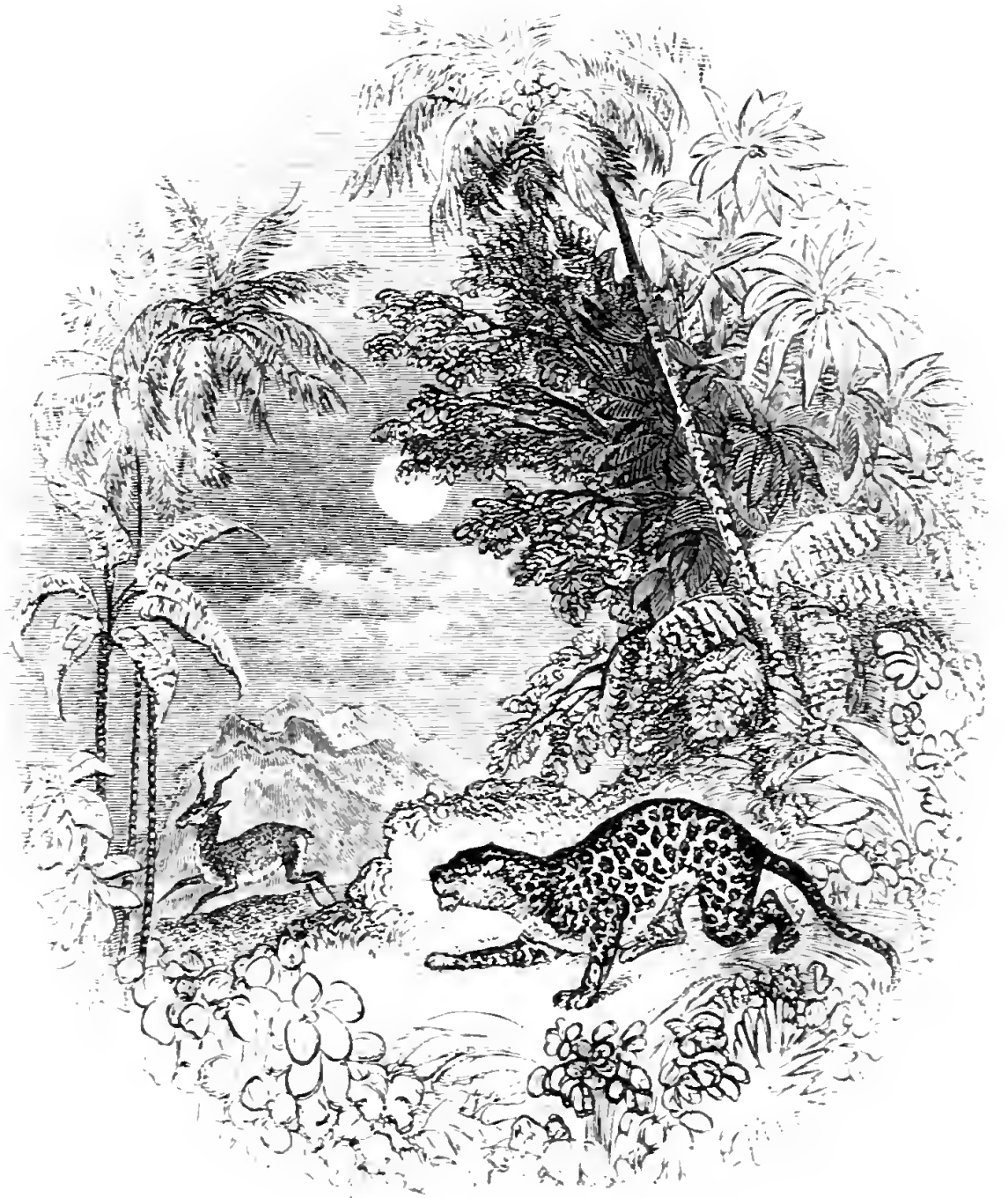
nia

P. Hoorkstank



MOONLIGHT IN AFRICA.

LIGHT:

ITS

PROPERTIES AND EFFECTS.

Great source of day! blest image here below
Of thy Creator, ever pouring wide
From world to world the vital ocean round,
On nature write with every beam His praise.

THOMSON.

LONDON:
THE RELIGIOUS TRACT SOCIETY;
Instituted 1799.
SOLD AT THE DEPOSITORY, 56, PATERNOSTER ROW;
AND 65, ST. PAUL'S CHURCHYARD; AND
BY THE BOOKSELLERS.

1840.

LONDON:
PRINTED BY SAMUEL BENTLEY,
Bangor House, Shoe Lane.

CONTENTS.

CHAPTER I.

Page

The Origin of all things—The Claims of God as a Creator—Luminous Plants—The Phosphorescence of the Sea—Number of Marine Animals—Providential Care—The Glow-worm—The Fire-fly—The Candle-fly 1

CHAPTER II.

Meteors—The Star of Jacob—The Magi—The Divine Redeemer—The Sun of Righteousness—Rising and Setting of the Sun and Stars—Sunrise in Italy 15

CHAPTER III.

The Statue of Memnon—The Morning Hymn of Adam and Eve—The only Saviour—The Moon—Singular effects of Moonlight—Joshua's command to the Sun and Moon—The Shadow going back on the Sun-dial of Ahaz—The Darkness at the Crucifixion 25

209112

CHAPTER IV.

Page

Something congenial in Light and repulsive in Darkness—Different theories of Light—Curious Experiment, in which two sounds produce silence—Mosaic Narrative of the Creation—Nebulous Matter—Faith in the word of God—General Properties of Light—Substances neither perfectly transparent nor opaque—Shadows—Cowper's Winter Morning Walk—Light moves in straight lines—Velocity of Light . . . 39

CHAPTER V.

Angle of Reflection—Burning Mirrors of Archimedes—Modern Experiments—Reflection of Light—Illusions of Ancient Times—The Phantom Box—Advantages of Science—The Holy Scriptures—Light on the Water—The blue appearance of the Sky—The Twinkling of the Stars 53

CHAPTER VI.

The Atmosphere the medium of Light—Its Refractive Power illustrated—Spectral Illusions—The Mirage—Appearance of Water in Africa—Remarkable Spectacle at the Pharo of Messina—Another in France—Gigantic Figure on the Hartz Mountains—Effect of a Fog . . . 65

CHAPTER VII.

Effect of Light of only one Colour—Curious Experiment—Beauty of Flowers—The Plumage of Birds—Colours of the Dolphin—Diversity in Human Complexion—The Rainbow—Visions of the Apostle John—Singular Appearances—Experiments of Sir Isaac Newton—Decomposition of Light 80

CHAPTER VIII.

Page

Absorption of Light—Transparent Bodies—Transmission of Light—Colours of thick plates—Mother-of-Pearl—Iris ornaments—Inability to distinguish colours 96

CHAPTER IX.

Admirable structure of the Eye—Its Humours—The Retina—Astonishing sensibility of the organ of sight—Care of the Great Artificer—Motions of the Eye—Its use—Curious Experiment—Modern Discoveries—Interesting Fable 104

CHAPTER X.

Effect of Experience on sight—Various auxiliaries in judging of objects—Account of a boy couched by Cheselden—Range of sight—Effect of Comparison—Circle of Light—The Thaumatrope—Anecdote of Dr. Darwin—False impressions produced by disease—Wonders of Vision—Expression of the Eye—The Brazen Serpent 119

CHAPTER XI.

Effects of Lenses—The Camera Obscura—The Magic Lantern—The Angle of Vision—Invention of the Telescope—Galileo—Father Zucchius—Reflecting Telescopes—Sir Isaac Newton—Labours of Sir William Herschel—Obstacles to Vision from the dispersion of the coloured rays

Page

—Structure of the Achromatic Telescope—Efforts of John Dollond—Sketch of Guinand—Microscopes—Wonders exhibited by such instruments—Experiments on the Fibres of Flax and Cotton—Importance of such researches—Contrast between the Works of God and of Man . 136

CHAPTER XII.

Value of artificial Light—Ancient Bronze Lamps—Experiments of M. Argand—Dangers of Miners—Evils of Sin—Efforts of Sir Humphrey Davy—Revelation an infallible Safety Lamp—Gaseous Exhalations in India, Persia, and China—Springs charged with Gas in New York—Modern Manufacture of Gas anticipated—Useful and important Discoveries long delayed—History of Gas-lighting—Cooking by Gas . . 160

CHAPTER XIII.

The Privation of Light a proof of the Divine care—Its effect on inferior creatures—The Slumber of Vegetables—Anecdote of Linnæus—Results of Plants growing in the dark—The Respiration of Plants—Discoveries of Dr. Priestly—Experiment of M. de Candolle—Sunset on Lakes, in India, and in America—Lustre of the Moon in Africa—Refreshment of Sleep—Morning and Evening Prayer—There is no night in Heaven 175

LIST OF ENGRAVINGS.

Moonlight in Africa . . Frontispiece.

Page

Luminous Marine Animals 6
Candle Flies 14
The Magi 18
Sunrise in Italy 24
Joshua 34
Nebulæ 44
Pencil of Rays 47
Shadows 49
Angles of reflection and of incidence 53
Burning Mirrors of Archimedes 54
Lenses 57
Apparent direction of a Star 66
Spectral Illusion 68
Ship, with direct and inverted images . . . 71
Experiment to illustrate refraction 72
Landscape in the Desert 74
The Rainbow 88
Refrangibility of the seven colours 92

Page

The Prism 93
Composition of Light 94
Lines in Mother-of-Pearl 101
The Eye 104
Section of the Eye 106
Lachrymal Glands 109
The Trochlear Muscle 110
The Levator palpebræ superioris 111
Effect of distance 123
The Thaumatrope 127
The Brazen Serpent 134
Effect of a Lens 137
Ditto 138
The Camera Obscura 138
The Magic Lantern 139
The Angle of Vision 140
Dispersion of the coloured rays 145
Structure of the Achromatic Telescope . . . 147
The Double Microscope 152
The Coal Mine 164
The Safety Lamp 167
Evening 176
Sunset in India 186

LIGHT:

ITS PROPERTIES AND EFFECTS.

CHAPTER I.

THE ORIGIN OF ALL THINGS—PHOSPHORESCENCE—THE CARE OF GOD.

THE great truth, that "in the beginning God created the heaven and the earth," we owe entirely to Divine inspiration. No human eye could have witnessed that event; and, in reference to it, the most distinguished men of ancient times were much perplexed. Indeed, it was more common for those who were considered enlightened people to derive their gods from the world, than to ascribe the universe to God.

One favourite idea was, that the system of things which attracts our attention, and ought ever to excite admiration, had *no* origin; but that what it was, it had

been from eternity. Now, it is worthy of remark, that if the world had been one uniform whole, such a state might have appeared possible. But, on the contrary, so far from being simple, everything is compounded. It is easily seen that this assertion applies to the grosser forms of matter, yet it is indisputably true of those which are most refined. At no distant period, much was heard, for instance, about "the elements of nature;" yet these have been found capable of still further division. Thus the simplest forms of which men could at one time conceive, are manifestly combinations of what is far more simple.

And here is a proof that the universe cannot have existed from eternity; because, as it is compounded of various parts, so these must have been previously in some other state. As the timber of the house was in the forest; and the clay, the stone, and the metal, in the earth; so these are all to be traced to more simple forms, in which they must have been prior to their combination. The house cannot be erected without its parts being first produced; and the globe, formed of various substances as it is, could not have been always in its present condition: it must, therefore, have had a beginning.

To this, then, we are directed, in the inspired declara-

tion of Moses: — "In the beginning God created the heaven and the earth." This may be regarded as a preface to the whole Bible, and to the system of doctrines it contains. Accordingly, it announces, in few and simple, but most sublime and affecting terms, the two great subjects about which they are employed — Jehovah and his kingdom: it exhibits him as the supreme Creator, and all things, visible and invisible, as the products of his wisdom, power, and goodness.

On this act is founded a great part of the character in which he specially claims the obedience of intelligent beings. As the Creator of the universe, he shows himself able to preserve and govern the vast work which he has thus made. It is evident that he has power which nothing can resist or escape, wisdom which nothing can elude or approach, and greatness with which nothing can possibly be compared. Creation, too, gives the highest claim; and hence he is the absolute Proprietor of all. He who says, "Every beast of the forest is mine, and the cattle upon a thousand hills," has the same property in the humble and the exalted — from the smallest atom to the loftiest archangel. "He doeth according to his will in the army of heaven, and among the inhabitants of the earth: and none can stay his hand, or say unto him, What doest thou?" Dan. iv. 35.

It is a singular fact, that while Moses says, when the earth was without form and void, "Darkness was upon the face of the deep," some traces of this truth are found among most nations. Aristotle speaks of some of the learned, as saying, "All things are born from night." Hesiod describes chaos as the origin of all things, from which Erebus and Night arose. Aristophanes also intimates that this idea was common among the intelligent men of Greece.

The Anglo-Saxons began their computation of time from night, and their year from that day in winter corresponding with our Christmas, which they called, "Mother Night," as if it were the parent of all things. The Tahitians, and other islanders of the Great Pacific, refer the first existence of their principal deities to the state of darkness, which they make the origin of all things. These are said to be, "Fanau Po," born of night; "Po" is the world of darkness. How delightful is it to the Christian, when reading such facts, to review his own exalted privilege, in being possessed of the revelation of that God to whom "the darkness and the light are both alike!" Psal. cxxxix. 12.

According to the sacred historian, the first element separated from the chaos was light, the most wonderful and useful of all material objects. The Divine com-

mand was issued, and immediately obeyed. The Hebrew words recorded are only four: "And God said, *Light be*, and *light was;*" and hence they have been quoted as an instance of sublime writing from the time of Longinus, an ancient critic. Milton also appears to have felt it in its full force, from the opening of his hymn:—

"Hail, holy light! offspring of heaven, first-born."

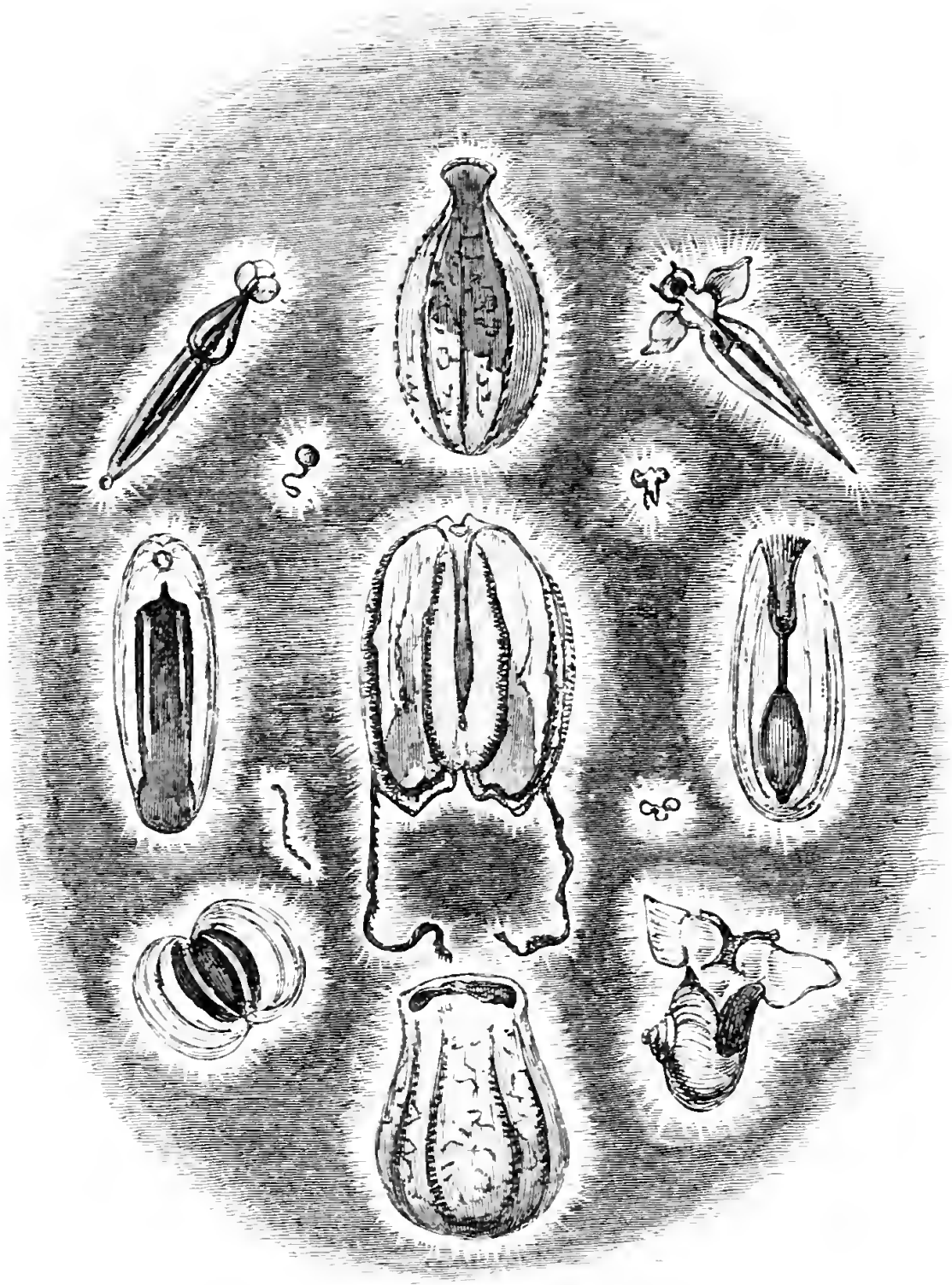
In reference to this element it is that some interesting facts are now to be stated, while from them may be derived many lessons calculated to improve as well as to inform the mind. For that is, after all, but a vain philosophy which does not lead the soul to Him who styled himself, "The Light of the world," John viii. 12. Earnestly is it desired that a contrast may appear in the happy result of the illustrations of the Divine agency which are now to be offered.

To commence with some instances of phosphorescence, it may be remarked, that certain plants are luminous. A gentleman observed, in the shady recesses of some of the rocks of Derbyshire, a singularly brilliant golden-green light, rivalling the gorgeous tints of the humming-bird, which appeared to have been given out by a very delicate vegetable net-work.

In the coal mines in the vicinity of Dresden, too, there are some mosses which are said to be abundant and luminous. They are described by a visitor as appearing in "wonderful beauty;" and he says, "The impression produced by the spectacle I shall never forget. The abundance of these plants was so great, that the roof, and the walls, and the pillars, were entirely covered with them; the beautiful light they cast around was almost dazzling; it resembled faint moonshine, so that two persons near each other could readily distinguish their bodies."

The phosphorescence of the sea presents a most remarkable spectacle. Sometimes the vessel, while ploughing her way through the billows, appears to mark out a furrow of fire. Each stroke of an oar gives rise to sparks of light, sometimes tranquil and pearly, at others brilliant and dazzling. These moveable lights, too, are grouped in endless varieties; their thousands of luminous points, like little stars, appearing to float on the surface; and their matter forming one vast sheet of light. At such times, the bright waves heave up, roll, and break in shining foam; or large sparkling bodies, resembling the forms of fishes, pursue each other, disappearing and bursting forth anew.

Beautiful illuminations of the same kind are frequently



LUMINOUS MARINE ANIMALS.

seen at a great depth in the clear water, which in the night-time become jet black. Often through this dark, yet limpid medium, have voyagers amused themselves by tracking the routes of large fishes, such as porpoises or sharks, gleaming along in lines of light beneath the abyss, itself invisible with gloom.

As Captain Tuckey passed in his voyage towards Prince's Island, the ship seemed to be sailing on a sea of milk. In order to discover the cause of such an appearance, a bag, having its mouth distended by a hoop, was kept overboard, and by means of it vast numbers of small animals were collected. Among them were a great many pellucid scalpæ, with innumerable little creatures attached to them, to which Captain Tuckey principally attributed the whitish colour of the water.

Thirteen species of cancer were observed, not above one-fourth of an inch long; eight having the shape of crabs, and five that of shrimps. Among these, some luminous creatures were discernible. When one species was examined by the microscope, in candle-light, the luminous property was observed to reside in the brain, which, when the animal was at rest, resembled a most brilliant amethyst, about the size of a large pin's head; and from this there darted, when the animal moved, flashes of a brilliant and silvery light.

Of the number of these little creatures, of some of which a magnified representation has been given, some interesting statements are furnished by Captain Scoresby. "During a run of fifty leagues," he says, "the sea was constantly of an olive green colour, remarkably tinted; but on the afternoon of the 17th of April, it changed to transparent blue. This green appearance of the sea in these latitudes was occasioned by myriads of small marine animals. A calculation of the number of these animals, in the space of two miles square, and 250 fathoms deep, gave an amount of 23,888,000,000,000. On September the 1st, the sea was observed coloured in veins or patches of a brown colour, or sometimes with a yellowish green; and this water, on being examined by the microscope, appeared swarming with minute marine animals. A drop of this water contained 26,500 animalcules. Hence, reckoning sixty drops to a drachm, there would be a number, in a gallon of water, exceeding by one half the amount of the population of the whole globe. It affords an interesting conception of the minuteness of some tribes of animals, when we think of more than 26,000 individuals living, obtaining subsistence, and moving perfectly at their ease, in a single drop of water." A sea is required for a whale to sport in; but a common

tumbler affords abundant space for a hundred and fifty millions of these little creatures.

The phosphorescent appearances presented by them are not, however, without an important design. It is probable that God, whose knowledge is unbounded, foreseeing that man would learn to traverse the mighty deep, and explore the most distant regions of the globe, has given this brightness to the ocean to lessen his dangers, and to render his nights less gloomy.

Especially will this seem likely when it is remembered, that it is only seen in the night season, and is vivid in proportion to the darkness. It disappears before even the feeble light of the moon, and increases with the agitation of the sea; so that during the prevalence of storms, it greatly diminishes the dense gloom which at such times even the moon and stars cannot penetrate. It casts such a light on the ship and the rigging, that the sailors may execute their allotted tasks with certainty; and at all times it points out to the cautious mariner the lurking danger of sunken rocks, shoals, and unknown coasts.

How delightful is it to dwell on such proofs of the Divine care! "Are not," said the gracious Redeemer, "five sparrows sold for two farthings, and not one of them is forgotten before God? But even the very hairs

of your head are all numbered," Luke xii. 6, 7. Nor let it be supposed that such minuteness of regard is not of unspeakable importance. On a circumstance, apparently inconsiderable, others of evident magnitude may depend. Captain Cook, for instance, was sailing on the ocean in a dark and tempestuous night, when a flash of lightning discovered to him a vessel which glanced along close by his side, of which, but for the lightning, he must have run foul. It might be thought improbable that two ships, steering from parts of the world very far distant from each other, should yet move so exactly in a line as to dash against each other in the midst of the vast Pacific Ocean, to fill, and to go to the bottom, in a sea where all the ships in the world might be so dispersed as that no one should be seen by the sailors on board another; yet this must have happened but for that flash of lightning which obeyed the command of the God of providence!

The same gracious superintendence extends to ourselves in our most minute concerns, if we love God, and are the called according to his purpose, Rom. viii. 28. In this case, we may look for the tenderest proofs of Divine regard. We shall then know the God and Father of our Lord Jesus Christ to be *our* Father. How important, therefore, is the inquiry, Do *I* love God?

For if any man love not the Lord Jesus Christ, he is labouring under a tremendous curse, and exposed to future and remediless woe. How sad is it when any, without the least scrutiny into their state, suppose *they* may rejoice in the doctrine of Providence, when it is unhappily evident that they have no hope, and are without God in the world! To those who are reconciled to him through the death of his Son, and to those alone, it is said, "All things are yours; whether life, or death, or things present, or things to come; all are yours; and ye are Christ's; and Christ is God's," 1 Cor. iii. 21—23.

Passing now from these all-important considerations, it may be remarked, that larger creatures than those already referred to, yet residing in the waters, are sometimes luminous. Thus Pliny, a very celebrated Roman philosopher, was aware that certain fishes have the property of diffusing light around them, and imagined it to be occasioned by a fluid with which they are covered. His countrymen, who indulged their appetites to great excess, were accustomed to eat a shell-fish, called the pholas, in darkened apartments, that they might have the pleasure of seeing the scintillations emitted while they gratified their palates.

Other instances of the same kind might be easily

specified. A traveller in distant lands, for example, says: "The river abounded with fish; it glowed with phosphorescent light; as we passed over, though it was as dark as pitch, the boat was actually illuminated with shoals of moving lights, that played around us in the most singular manner, every fish being encircled with a bright halo."

In our own country, we are not unacquainted with such appearances. The glow-worm, a little creature something like a caterpillar, is generally found to inhabit the borders of paths, and the outer margins of woods and coppices, especially in low situations, where it is observable after the heat of the day is over, and when the dew is falling. Still it is not a caterpillar, but the perfect female of a beetle; and is destitute of wings, with which the male is furnished. Its light, which is of a beautiful sulphur colour, proceeds from the last three segments of the body. So strong is it, that it is seen through several folds of paper, in which the glow-worm may be wrapped; and by it a small print may be read without difficulty, or the time seen by a watch.

The glow-worm, however, is not the only insect capable of emitting a light; for this property is possessed in common by several species in different orders. But the light is displayed from various parts of their bodies.

Mr. Afzelius placed a rare insect from Africa in a box, and on opening it a phosphoric light issued from the globes of the antennæ, or horns, which, he says, appeared like two lanterns. Several times he observed it during the evening, but on the following morning the insect was dead, and the light had disappeared.

The fire-fly of South America is about an inch long, and one-third of an inch broad; when on the wing it appears adorned with four brilliant gems of the most beautiful golden-blue lustre; in fact, the whole body is said to be full of luminous matter, which shines forth between the rings of the abdomen when stretched.

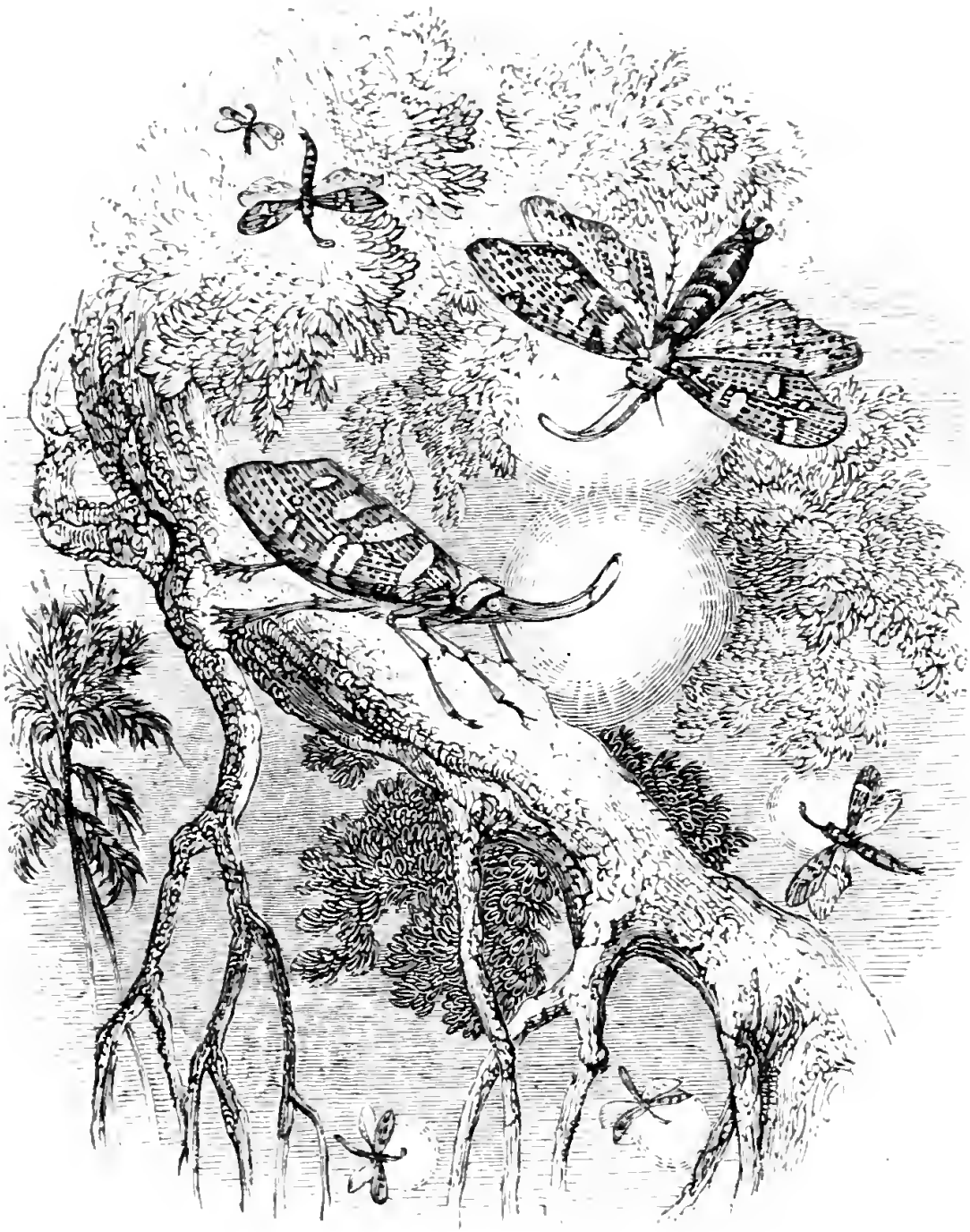
The light, which proceeds from the two spots on the thorax, placed immediately behind the head, is said to be sufficient for a person to read the smallest print, by moving one of these insects, when placed between the fingers, with the light downwards along the line; and when several are put together in a glass or any other transparent tube, the light will be sufficiently great for writing by it.

A traveller says: "I could not but admire the thousands and tens of thousands of fire-flies that spangled the gulf below, a tiny galaxy; they did not twinkle promiscuously, but seemed to emit their small green light by signals, beginning at the head of the

ravine, and glaring all the way down in a wavy, continuous, lambent flash."

At night, the lantern-fly glitters by thousands among the dark recesses of the banyan tree; and may also be observed dancing in perpetual motion around the outer branches of the spreading tamarind, producing a brilliant and singularly beautiful effect.

A similar power is also possessed by the candle-fly. The real object of it is not thoroughly understood; but it is supposed to be designed to enable it to discover its prey, and to steer itself safely in the night.



CANDLE FLIES.

CHAPTER II.

LUMINOUS BODIES—THE STAR IN THE EAST—DIGNITY OF THE SON OF GOD.

INTERESTING as are the instances of phosphorescence, already given, there are other luminous appearances of a far higher order. Among these are the meteors which sometimes attract the eye. They are a few out of, perhaps, myriads of bodies wandering through space, of whose nature we cannot form an idea, any more than of the end they have to answer.

A traveller, who had just passed from the dark and turbulent waves of the Atlantic, to the calm and gentle waters of the Mediterranean, states, that while the day presented pleasing objects, others equally lovely appeared at night, in the glittering firmament of new stars, and in the various meteors which shot in all directions across the horizon. One of them was exceedingly beautiful; it burst from the sky near the Pleiades, and struck all who were on the quarter-deck with awe and amazement. It presented the appearance of a dense

cone of fire, apparently about two feet long, and nine inches broad. It proceeded, with the base foremost, at a slow and majestic pace, illuminating the whole hemisphere, completely obscuring the stars, and rendering every object both on and around the vessel distinctly visible.

Near the horizon were some dark clouds, in separate strata; it passed behind these, and reappeared at intervals, tinging their skirts with a bright orange light, and it finally set in the north-west, among the mountains of Sardinia. Nothing, it is affirmed, could exceed the bland yet somewhat awful beauty of this splendid meteor; its light was so lovely, and its progress so dignified. It continued visible for more than a minute, and traversed one-third of the sky.

A still more remarkable appearance was connected with the incarnation of the Son of God. It was said by Balaam, "There shall come a Star out of Jacob;" and in connexion with this prophecy some circumstances may be noticed of great interest. A certain sect in Persia bore the name of Magi; and their study seems to have been the solar system. At first, perhaps, their object was merely to learn from the heavens the glory of God, but they sunk at length into an adoration of the orbs of the firmament.

Some, however, appear to have been preserved from this great evil, or to have been converted from it. Amidst these circumstances, an extraordinary event occurred: an unknown star appeared in the heavens, the figure and motions of which convinced them that it was supernatural. Immediately it was connected in their minds with the King of the Jews, and they felt it was *his* star. It can, therefore, be scarcely doubted that Balaam's prophecy was known among the mountains of the East, and that these sages understood this luminous appearance to refer to Him who was announced as "the Star of Jacob."

To its guidance they committed themselves, with high expectations; and it appears that, as soon as they arrived in Jerusalem, they inquired for the King of the Jews, supposing that all could tell the place where he was to be found. But those they addressed led the strangers to the court, concluding that their errand referred to some event which had occurred in the royal family, of which the public might be ignorant. Herod was, however, troubled by such inquiries, and all Jerusalem with him; for they well knew his jealous and cruel mind, and dreaded some new massacre to cut off this rival prince. He now summoned the priests and scribes to know where the promised Messiah was to be

born; and they immediately, quoting the prophecy of Micah, decided it was to be at Bethlehem, Micah v. 2; Matt. ii. 5, 6.

Herod, having secretly called for the wise men, pretended to welcome them to consult with him on the mode of concurring in the object they pursued. Learning the time of the star's appearing, he dismissed them with a charge to bring him word when they had found the illustrious Infant, that he also might lay his honours at the feet of the rightful heir to the throne of David. To lull their suspicions, Herod sent no guards with them; and to prevent exciting the jealousy of the king, some of the people of the city accompanied the strangers.

When the sages had turned their backs on Jerusalem, they regained the sight of the luminous appearance they had first beheld. It seems, however, that it was not till they arrived near the ancient city of David that they saw the meteor; for though Bethlehem was not more than seven miles from the capital, yet, if it were in the hot season, they would choose the evening for travelling; and thus it was ordered that they should arrive when the departure of the sun left the stars and any other luminous body visible. But now they had an unfailing guide; for "lo, the star, which they saw in the east, went before them, till it came and stood over where the

THE MAGI.

young child was," Matt. ii. 9. Great was their joy at this event; and, on reaching the memorable spot where the infant Saviour appeared, they "fell down, and worshipped him: and when they had opened their treasures, they presented unto him gifts; gold, and frankincense, and myrrh," Matt. ii. 11.

The guide to these sages accorded well with the nature of Him to whom they were conducted, so far as the finite can shadow forth the Infinite. It is said that, in the hieroglyphics of Egypt, a star denoted the Deity. Thus God also reproved Israel, saying, "Ye have borne the tabernacle of your Moloch and Chiun your images, the star of your god, which ye made to yourselves," Amos v. 26. In like manner, the first martyr, Stephen, testified against them, "Yea, ye took up the tabernacle of Moloch, and the star of your god Remphan, figures which ye made to worship them;" and which were, therefore, doubtless considered appropriate emblems of the Divinity. Acts vii. 43.

The figure of a star was used, according to the genius of Eastern language, to shadow forth the dignity of the Saviour's nature. "Great is the mystery of godliness: God was manifest in the flesh," 1 Tim. iii. 16. "The Word," says the beloved disciple, "was God. — And the Word was made flesh, and dwelt among us, (and we

beheld his glory, the glory as of the only begotten of the Father,) full of grace and truth," John i. 1. 14. No wonder, then, that Jesus should say, "I and my Father are one," John x. 30.

Never should this most important truth be overlooked. The Babe of Bethlehem, the Man of Sorrows, the Victim on Calvary, is the eternal God. He who created all things, whether visible or invisible; he who upholds them by the word of his power; he who will one day raise the dead, summon every individual of the human family to his bar, and pronounce on each one a sentence which shall never be altered—is the great and only Mediator. How worthy is he of our love and our confidence! His knowledge is unbounded, his wisdom cannot be fathomed, his power is almighty. All are in danger who are exposed to the shafts of his anger; none are insecure to whom he deigns to manifest his love.

It is, moreover, our unspeakable happiness to know, that he is both able and willing to manifest himself to every one who humbly waits upon him. Of this we are assured in language suited to the present subject; for at the close of the inspired volume, the gracious proclamation is made to the world, "I Jesus have sent mine angel to testify unto you these things in the churches, I am the root and the offspring of David and the bright

and morning star. And the Spirit and the bride say, Come. And let him that heareth say, Come. And let him that is athirst come. And whosoever will, let him take the water of life freely," Rev. xxii. 16, 17.

And if the New Testament thus exhibits the Saviour of the world, his majesty and his mercy are also displayed in figurative language in the Old Testament. May every reader verify, by heartfelt experience, the declaration of the last of the prophets, as he said by the inspiration of the Most High, " Unto you that fear my name shall the Sun of righteousness arise with healing in his wings," Mal. iv. 2.

The grand source of light as well as heat to the earth and all other planets is the sun. It has a very dense atmosphere. It is impossible to tell what its body may be, but it appears to be surrounded by a mottled ocean of flame. The solar rays pass through space in all directions ; yet, notwithstanding the magnitude of the sun, and the intense heat that must exist at its surface, it diminishes as distance increases, and even its kindly influences can hardly be felt at the boundaries of that system of worlds of which ours is a part.

The direct light of the sun has been estimated to be equal to that of 5563 wax candles of moderate size, supposed to be placed at the distance of a foot from the

object. It is computed that the height of the atmosphere surrounding the sun is not less than 1843, nor more than 2765 miles: it is supposed to consist of two regions; that nearest the sun being opaque, and probably resembling the clouds of our earth; the outermost emitting vast quantities of light, and forming the apparent luminous globe we behold. That it appears so small to us, is owing to its vast distance, which is no less than ninety-five millions of miles. A faint idea of this distance may be obtained by considering that a steam-boat, moving at the rate of 200 miles a day, would be 1300 years before it could traverse the space which intervenes between us and the sun.

A remarkable fact should here be noticed. The sun and the stars appear to rise and set, passing from east to west; but the appearance is deceptive, and is caused by the rotation of the earth on its axis from west to east. Thus the different parts of the globe are brought before the sun, and successively exposed to its influence. Those along the equator, or at an equal distance from each pole, move at a rate of rather more than a thousand miles per hour, while the other parts move with diminished velocity as they approach the poles. The apparent motion of the heavenly bodies, as rising

above or sinking below the horizon of the spectator, is easily explained by the fact of this daily rotation.

That we are without any sense of such motion is no evidence against its taking place. Apart from more scientific reasons, there are certain well-established facts, which place such a rotation, though we are not conscious of it, beyond all doubt. A short time since, for example, some friends of the writer's were on board a vessel in St. Catherine's Docks, busily employed in arranging packages for others about to embark for a foreign shore, when, after some time, coming on deck, they found the ship was being towed by a steam-boat, and that, not aware of the circumstance, they were then opposite Greenwich. Some even went on to Gravesend, from the difficulty of disembarking, in consequence of the progress of the vessel, to which they were before insensible.

In like manner, the aeronaut travels, perhaps, eighty miles an hour, without a sense of motion, unless he can judge of it from some objects within view. While the balloon ascends, it appears to him as if the earth were sinking beneath him ; and as he returns from his aerial trip, as if it rose to welcome his coming. We shall err, therefore, if we decide merely from appearances. Nor

should it be forgotten, that we are sensible of motion when there are objects to resist, or when they are approached or left behind; but here, as all things move with us, and that with perfect smoothness and freedom from whatever is opposing or jarring, we are without any ordinary means of bringing before us the fact.

What a splendid object is the rising sun! It is so in our own land, yet it is still more so when the traveller in Italy beholds the morning dawn, and the ascending orb shedding over the Sabine mountains a rich glow, gradually softening, as it becomes more distinct, into purple, lining with gold a few fleecy clouds which strew his path, and at length pouring a stream of the brightest saffron over all the eastern sky. Even in our northern climate, the tints that gild the clouds are as rich and varied as can well be imagined; but the deep purple distances of the horizon, and the gleaming yellow of the firmament, in Italy, far surpass ours in hue and splendour, and produce that lucid atmosphere so long noticed and admired. "In the contemplation of this beautiful and ever-varying phenomenon," says Eustace, "we drove on till we reached the first post, and then enjoyed the glories of the rising sun, till, concealing himself in a golden-fringed cloud, as in a chariot, he darted his rays from behind it, and set the whole firmament in a blaze."

SUN-RISE IN ITALY.

CHAPTER III.

MORNING—THE SUN OF RIGHTEOUSNESS—MOONLIGHT—SCRIPTURAL FACTS.

It is said, that there was in ancient Egypt a statue of Memnon, the son of Aurora, looking towards the east, and that it spoke as soon as the rays of the rising sun fell on its mouth. The description of another ancient writer is more particular: "The statue emits sounds every morning at sunrise, which can be compared only to that of breaking the string of a lyre." Strabo speaks only of a single sound which he heard; but Juvenal, who had probably often listened to it, describes it as if it emitted several sounds. These were afterwards formed into intelligible words, and even into an oracle of seven verses.

According to Sir David Brewster, Sir A. Smith, a modern traveller, accompanied by a party, examined the statue, and heard, very distinctly, at six o'clock in the morning, the sounds which, for ages, had been so celebrated. It is also stated, on the same authority,

that the problem it presents was first solved by means of an observation made by a solitary traveller wandering on the banks of the Orinoco. "The granitic rock," says Baron Humboldt, "on which we lay, is one of those where travellers on the Orinoco have heard, from time to time, towards sunrise, subterraneous sounds, resembling those of the organ. The missionaries called these stones *loxas de musica*. 'It is witchcraft,' said our young Indian pilot. We never ourselves heard these mysterious sounds, either at Carichana Vieja, or in the upper Orinoco; but from information given us by witnesses worthy of belief, the existence of a phenomenon that seems to depend on a certain state of the atmosphere cannot be denied. The shelves of rocks are full of very narrow and deep crevices. They are heated during the day to about 50°. I often found their temperature at the surface during the night, 39°, the surrounding atmosphere being at 28°. It may easily be conceived that the difference of temperature between the subterraneous and the external air attains its maximum about sunrise, or at that moment which is at the same time farther from the period of the maximum of the heat of the preceding day. May not these sounds of an organ, which are heard when a person sleeps upon the rock, his ear in contact

with the stone, be the effect of a current of air that issues out through the crevices? Does not the impulse of the air against the elastic spangles of mica that intercept the crevices contribute to modify the sounds? May we not admit that the ancient inhabitants of Egypt, in passing incessantly up and down the Nile, had made the same observation on some rocks of the Thebaid, and that the music of the rocks there led to the jugglery of the priests in the statue of Memnon?"

It is also a singular fact that, about the same time Humboldt was traversing the wilds of South America, three travellers in Egypt heard at sunrise, in a monument of granite, situated near the centre of the spot on which the palace of Carnac stands, a noise resembling that of a breaking string, the very expression by which Pausanias described the sound of the statue of Memnon.

It appears strange, however, that the Prussian and the French travellers should not have gone a step farther, and solved the problem of two thousand years, by maintaining that the sound of the statue was a natural phenomenon, or a granite sound produced at sunrise by the very same causes which operated on the Orinoco, and in the temple of Carnac, instead of regarding it as a trick in imitation of natural sounds. If, as Humboldt supposes, the people of Egypt, passing up

and down the Nile, became familiar with the music of granite rocks, how could the imitation of such natural and familiar sounds be rendered a means of deceiving the people? They would only consider the granite statue as like the granite rock, and regard the sounds from each as merely natural effects. As, however, it is a mere conjecture that such sounds were common in that part of the earth, it is probable, as Brewster thinks, that a granite rock possessing the property of giving forth sounds at sunrise had been discovered by the priests, and that the block was employed in forming the statue of Memnon, for the purpose of enabling them to maintain their influence over a credulous people.

But while rocks give forth their sounds at the rising of the sun, a tribute is certainly due to its great Creator from all his intelligent creatures. How beautifully has Milton described that of our first parents!

——————— "To the field they haste;
But first, from under shady arborous roof
Soon as they forth were come to open sight
Of day-spring and the sun, who, scarce uprisen,
With wheels yet hovering o'er the ocean-brim,
Shot parallel to the earth his dewy ray,
Discovering in wide landscape all the east
Of Paradise and Eden's happy plains,
Lowly they bowed adoring, and began

Their orisons, each morning duly paid
In various style."

The song our great poet has described them as raising, thus begins:—

"These are thy glorious works, Parent of good,
Almighty! Thine this universal frame,
Thus wondrous fair; thyself how wondrous then!
Unspeakable! who sittest above these heavens,
To us invisible, or dimly seen
In these thy lowest works; yet these declare
Thy goodness beyond thought, and power divine."

Having called on universal nature to extol the eternal Father, first, last, midst, and without end, the morning hymn of Adam and Eve thus concludes:—

"Hail, universal Lord! be bounteous still
To give us only good; and if the night
Have gathered aught of evil or concealed,
Disperse it, as now light dispels the dark."

And truly every morning calls for *our* tribute to God. To be preserved by Him in whom "we live, and move, and have our being;" to sleep in safety, and to rise in peace, because he sustains us; to have the provision ready which is needful for our bodily wants is a great mercy; and to be welcomed to his footstool, there to entreat a continuance of his favours, is an exalted privilege. Let it be ours, then, to consider it so, and dili-

gently to improve it: every morning may a grateful offering be presented to God; and, that it may be acceptable before Him who is of purer eyes than to look on iniquity, it must also be presented in the name and for the sake of that Redeemer, who, while our conduct calls every day and hour for condemnation, is "worthy to receive power, and riches, and wisdom, and strength, and honour, and glory, and blessing," Rev. v. 12.

As the orb of day is in the natural, so is he in the spiritual world, and hence is called, "the Sun of righteousness," Mal. iv. 2. In our system, there is but one sun; and, according to Divine revelation, there is but *one Saviour*. "I," he says, "am the way, the truth, and the life: no man cometh unto the Father, but by me," John xiv. 6. "Whatsoever ye do in word or deed," is the charge of an inspired apostle, "do all in the name of the Lord Jesus, giving thanks to God and the Father by him," Col. iii. 17. And, again, it is written, "Neither is there salvation in any other: for there is none other name under heaven given among men, whereby we must be saved," Acts iv. 12.

The sun in the firmament appears unimpoverished by the abundant influences already dispensed. At this moment he shines as brightly as he did when he beamed on the Saviour, while he went about doing good; on

Noah, when he entered with his family into the ark; or on Adam, when, in days of innocence, he walked amidst the beauties of Eden. In like manner, though all believers from primitive times, who enjoyed the institutions of Christianity; all who had the types and predictions of the former dispensations; and all who participated the privileges of patriarchs,—received from the fulness of Jesus, it is still undiminished; he is the same yesterday, to-day, and for ever. To Him, therefore, I may go, as confidently as if none had gone before; for he who has always been the great, the overflowing source of light—the light of knowledge, of purity, of hope, and of joy, is so still. Any other appeal will assuredly fail; but an application to Him, in the exercise of faith, will infallibly succeed. Truly the light is good; and a pleasant thing it is for the eyes to behold the sun; but he that seeth the Sun of righteousness, and believeth on him, hath everlasting life.

Nor let the freeness of the solar influences be forgotten. That glorious orb receives no offering at the hand of man; his beams fall on the whole human family, "without money and without price." And on these terms all spiritual blessings are offered to *us*. It is "not by works of righteousness which we have done," but according to the mercy of God alone, that we can be saved,

Titus iii. 5. At his foot, the proud and presumptuous Pharisee is rejected, while the penitent and believing publican goes down to his house justified. He asks of every suppliant an open hand and a grateful heart: they alone honour Him who waiteth to be gracious; they alone receive the boon.

Next to the sun, the moon is to us the most interesting of all the orbs of heaven, and the constant attendant of the earth on which we live. She is the nearest of all the heavenly bodies; being only about 240,000 miles distant from our globe. Seen through a telescope, her surface presents a variegated aspect, being diversified with mountains, valleys, rocks, and plains, in every form and position.

The light of the moon is probably only equal to the light of one candle placed at the distance of twelve feet from the object, and consequently the light of the sun is more than 300,000 times greater. The lunar rays, when collected in the most powerful mirrors, have no sensible effect on the thermometer. Indeed, they seem to produce cold, according to the experience of practical men. M. Arago was assured by the gardeners of Paris, that in the months of April and May, they had found the leaves and buds of their plants, when exposed to the full moon in a clear night, actually frozen, even when

the thermometer in the air was many degrees above the freezing point.

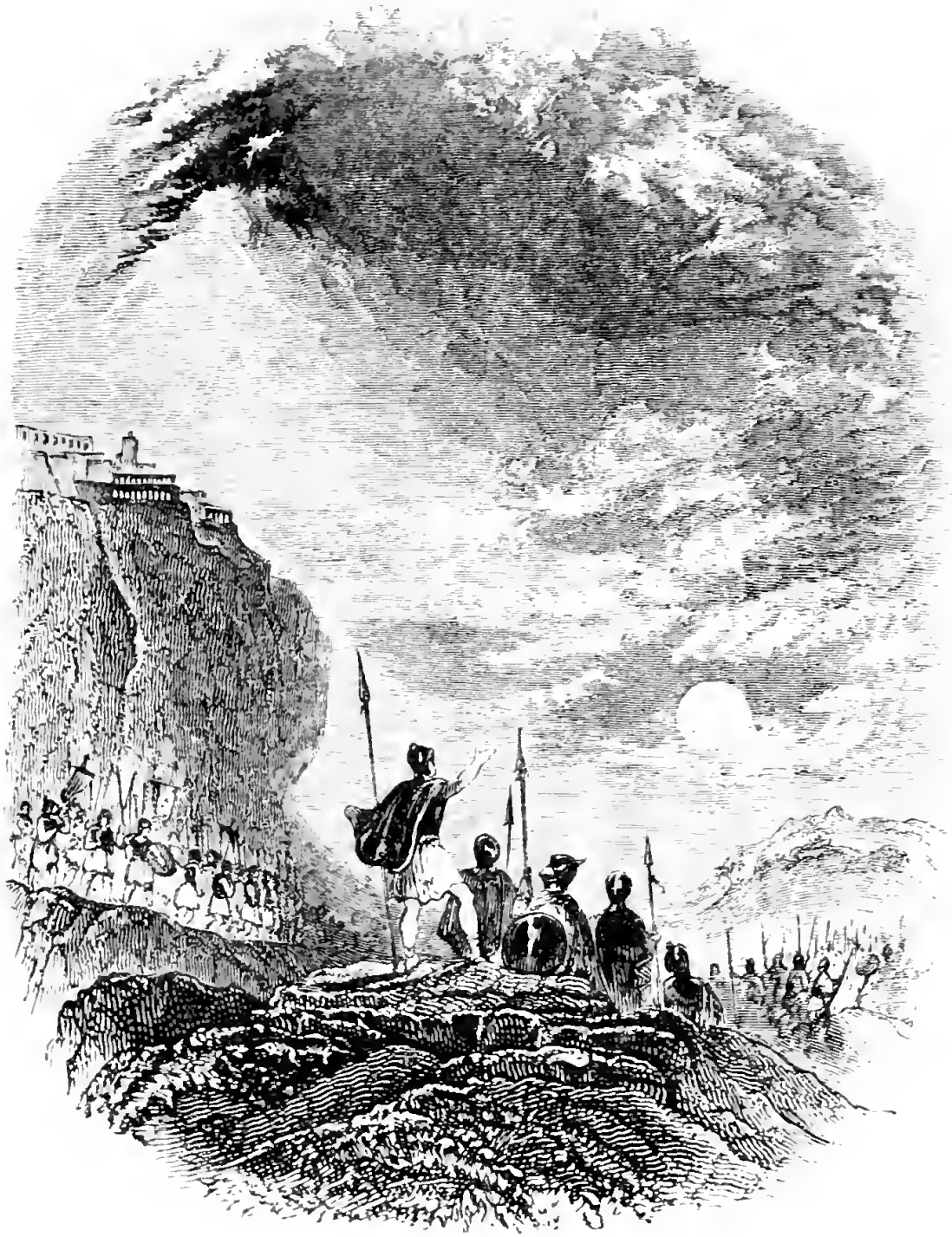
Another fact is also remarkable. Men on board a ship, while lying down in the moonlight, with their faces exposed to its beams, often have their muscles spasmodically distorted, and their mouths drawn awry; and others have been so injured in their sight, as to lose it for several months. Fish, when eaten after having been hung up during the night in the light of the moon, have occasioned great pain and violent sickness. Ages ago, Plutarch said, "Everybody knows that those who sleep abroad, under the influence of the moon, are not easily awaked, but seem stupid and senseless;" and the testimony of modern observers confirms the declaration. Mr. Carne says, in his Letters from the East, "The moon here really strikes and affects the sight, when you sleep exposed to it, much more than the sun, a fact of which I had a very unpleasant proof one night, and took care to guard against it afterwards; indeed, the sight of a person who should sleep with his face exposed at night would soon be utterly impaired or destroyed."

Decomposition goes on more rapidly when substances are exposed to the beams of the moon, than when the solar rays are acting upon them. Meat exposed to

them soon becomes putrescent. A knowledge of such facts will throw much light on the words of the psalmist, "The sun shall not smite thee by day, *nor the moon by night*," Psa. cxxi. 6.

A contrast to these circumstances must, however, be observed. Among the Hindoos, the moon is spoken of in the masculine gender, and is believed to have a very favourable influence on all fruits and vegetables used by man. "Whilst the sun burns," they say, "the moon cools." From the time of the new moon to its becoming full, all plants and all kinds of young grain are said to gain more strength than at any other time. In places where the young rice plants have failed, the farmer says, "I must put down some plants there in the new moon," from the idea that they will derive much nourishment from it. Before the time of reaping, it is often said, "The moon will bring forth the ears." Such ideas strikingly accord with the blessing pronounced by Moses on Joseph, which included "precious things put forth by *the moon*," Deut. xxxiii. 14.

There are yet some other circumstances recorded in Scripture, to which it will be well to allude. In the day when the Lord delivered up the Amorites before the children of Israel, Joshua said in the sight of the people: "Sun, stand thou still upon Gibeon; and thou,



JOSHUA.

Moon, in the valley of Ajalon." And the inspired historian adds: "And the sun stood still, and the moon stayed, until the people had avenged themselves upon their enemies," Josh. x. 12, 13.

Joshua doubtless acted on this occasion by an immediate impulse of the Spirit of God. It would have been improper for him to speak, and for the miracle to be recorded, according to the terms of modern astronomy. The sun appeared to the Israelites over Gibeon, and the moon over the valley of Ajalon, which is supposed to have been situated in a different direction; and there they appeared to be stayed in their course for a whole day; either for the space of about twelve or fourteen hours, or for the time of one diurnal revolution. It is conceived by many, that the purpose the miracle was designed to answer, was the giving a death-blow to the prevailing superstition of the country, the worship of the sun and moon. And obvious is it, that there is something truly sublime in supposing the deities of the conquered people thus arrested in their career, and forced, as it were, to witness the discomfiture, and contribute to the destruction, of their worshippers.

Many inquiries have been made as to the way in which this miracle was wrought. It ought, however, to satisfy our minds, when we are told by the Holy

Spirit that *so* it was, though we are not told *how* it was. The fact rests on the testimony of the God of truth; and the manner of its occurrence is probably beyond our comprehension.

Another remarkable fact should receive attention. In a season of affliction, Hezekiah addressed the great Dispenser of life and death, and added tears to his petitions. Scarcely had he finished his prayer, before Isaiah appeared with a message of peace—the message that his life should be lengthened for the space of fifteen years. As this would be a miraculous restoration, it was accompanied by an extraordinary sign: "And this shall be a sign unto thee from the Lord, that the Lord will do this thing that he hath spoken; behold, I will bring again the shadow of the degrees, which is gone down in the sun-dial of Ahaz, ten degrees backward. So the sun returned ten degrees, by which degrees it was gone down," 2 Kings xx. 1—11; Isa. xxxviii.

Of dials, constructed as such, we have no record in an age so remote as that of Hezekiah. The most ancient, of which we have any information, were semicircular; but these were some centuries later than the reign of that prince. The word rendered degrees literally signifies steps; and it has been supposed that the dial of Ahaz was merely a flight of steps in his

palace, so constructed that the rays of the sun fell on them during the day, throwing the shadow in different directions. This, it is thought, was noted in the various stages of its progress, and divided into spaces, sufficiently accurate to determine the larger Jewish divisions of time. Others conclude that it was an obelisk, set up in some open court of the palace, from which, as from a centre, different lines were drawn, at spaces determined by the course of the sun, and thus rendered descriptive of the passage of time. Others assign to it, however, the form of ancient instruments of that kind, usually divided into three parts, and containing some smaller degrees.

But, whatever was this measurer of time, it would seem that it stood within sight of the chamber where the afflicted monarch lay. He had cast many a mournful glance on the glorious orb changing its course, for Isaiah had before entered the palace, to pronounce on him the sentence of death. What, then, under these circumstances, could be more impressive, or more delightful, than the seal of the Divine promise, afforded by the miracle performed? The shadow, which had descended ten degrees on the dial, recedes and returns in the same proportion! Most happily did the sign accord with the gracious interposition.

A still more remarkable fact is connected with the crucifixion of Christ. The evangelist Matthew says: "From the sixth hour there was darkness over all the land unto the ninth hour," Matt. xxvii. 45. That this gloom was wholly preternatural, and not an eclipse of the sun, is placed beyond all doubt. It happened at the feast of the passover, which was celebrated only at the *full moon*, a time in which it was impossible for the sun to be eclipsed; such an event occurring only at the time of the *new moon*. No wonder that a spectator of the miracle is said to have observed, "Either the God of nature suffers, or sympathises with the sufferer." It gave a signal proof of the Divine displeasure against sin. Who does not see, by this darkness, the world called to gaze on the sufferer, and to inquire for what he submitted to death? All have, by transgression, forfeited the light of heaven,—one of the choicest gifts of God, and which opens to us all the glories of his works,—and exposed themselves to the woes of eternal darkness. With what earnestness of desire, then, should we, individually, be found seeking salvation! Jesus came "to give his life a ransom for many," Mark x. 45. "Wherefore he is able also to save them to the uttermost that come unto God by him, seeing he ever liveth to make intercession for them," Heb. vii. 25.

CHAPTER IV.

WHAT IS LIGHT—THE MOSAIC NARRATIVE ILLUSTRATED—REMARKABLE FACTS.

To human nature there is something so congenial in light, and so repulsive in darkness, that it is probable on this account alone the aspect of inanimate things is either grateful or the reverse, from its reminding us of one or the other. Thus, perhaps, particular colours, throughout the range of our observation, are more or less acceptable as they approach nearest or recede farthest from the character of this element, whether reflected directly from the heavenly bodies, from the azure of the sky, or from the brilliant hues with which the rising or the setting sun arrays its attendant clouds.

"In illustration of this principle," says Dr. Kidd, "gold and silver among metals might be opposed to lead and iron; and, among flowers, the brilliancy of the crocus, the lily, or the rose, to the lurid aspect of henbane or belladonna: and though something of a moral character may in these instances determine the preference,

yet there is nothing unreasonable in supposing that, as the instincts of the inferior animals regulate their tastes and distastes to natural objects, so there may also be, in the case of human beings, congruities or the reverse, between the sense impressed and the object impressing it. In fact, with respect to that sense the organ of which is the ear, it is known that infants shrink back from deep sounds, and express delight at acute sounds, long before any intellectual or moral feeling can sway them; and, correspondently with this assertion, the lullaby of the nurse partakes, among all nations, of the same essential character. It is a fact equally deducible from observation, that particular flavours and odours are naturally acceptable, or the reverse, to children. And again, with reference to the sense of touch, smooth surfaces almost universally give a pleasing impression, which is not imparted by rugged surfaces. Why, then, may it not be the same with respect to the sense of sight, in the case either of colour or of form?"

In dwelling still further on the element of light, the inquiry naturally arises, What is it? And this, it must be replied, is a question which cannot be fully answered. It was supposed by Newton, and most of his immediate successors, that light is a material substance,

consisting of particles emitted by luminous bodies, and moving through space with a velocity of 192,000 miles in a second.

Another theory is now generally adopted. According to this, an exceedingly thin and elastic medium, called ether, is supposed to fill all space, and to occupy the intervals between the particles of all material bodies. The particles of this ether, like those of air, are capable of being put into a state of vibration by the particles of luminous bodies which are constantly agitated; and when any of these vibrations, or undulations, as they are frequently called, are conveyed through the ether to the nerves of the retina, they are said to excite the sensation of light, just as the sensation of sound is excited in the nerves of the ear by the vibrations of the air. The analogy between them is strikingly shown by a very curious experiment mentioned by Sir D. Brewster. If two equal and similar strings perform exactly 100 vibrations in a second, they will produce each equal waves of sound, and these waves will conspire to produce an uninterrupted sound, double of either of the sounds heard separately. If the two strings are not in unison, but nearly so, as in the case where the one vibrates 100 and the other 101 times in a second, then at the first vibration the two sounds will

form one of double the strength of either; but the one will gradually gain on the other, till at the fiftieth vibration it has gained half a vibration on the other. At this instant *the two sounds will destroy one another, and an interval of perfect silence will take place.* The sound will instantly commence, and gradually increase, till it becomes loudest at the hundredth vibration, where the two vibrations unite in producing a sound double of either.

An interval of silence will again occur at the 150th, 250th, 350th vibration, or every second, while a sound of double the strength of either will be heard at the 200th, 300th, and 400th vibration. When the unison is very defective, or when there is a great difference between the number of vibrations which the two strings perform in a second, the successive sounds and intervals of silence resemble a rattle. With a powerful organ, the effect of this experiment is very fine, the repetition of the sounds, wow—wow—wow, representing the double sounds and the interval of silence which arises from the total extinction of the two separate sounds.

Still more surprising is the result in the case of light. If a beam of *red* light falls on the retina, we shall see distinctly the luminous object from which it comes; but if another ray of *red* light issues from another

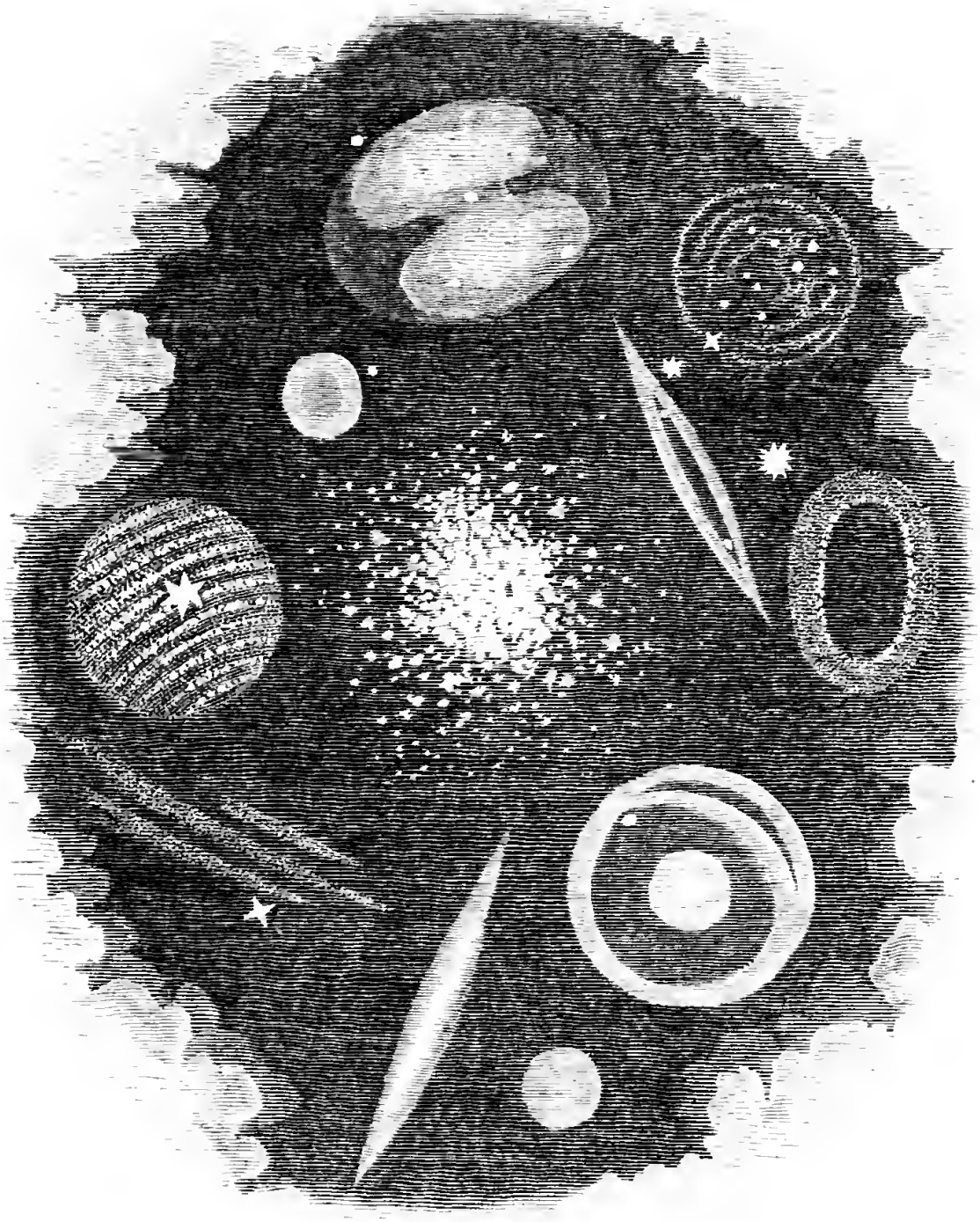
object, however situated, provided the difference between its distance and that of the other from the point of the retina on which the first beam fell, is the two hundred and fifty-eight thousandth part of an inch, or exactly twice, thrice, four times, &c. that distance—and if this second beam falls on the same point of the retina, the one light will increase the intensity of the other, and the eye will see twice as much light as when it received only one of the rays separately. All this is nothing more than might be expected from our ordinary experience. But if the difference in the distances of the two luminous points is only one half of the two hundred and fifty-eight thousandth part of an inch, or $1\frac{1}{2}$, $2\frac{1}{2}$, $3\frac{1}{2}$, $4\frac{1}{2}$ times that distance, *the one light will extinguish the other, and produce absolute darkness.*

It is worthy of observation, that, according to the Mosaic narrative, the creation of light preceded that of the sun. On the *first* day, "God saw the light, that it was good," but it was not until the *fourth* day that he said, "Let there be lights in the firmament of the heaven to divide the day from the night; and let them be for signs, and for seasons, and for days, and years," Gen. i. 4. 14. Now, as the sun is commonly considered the great source of light, the statement that *after* the existence and prevalence of this element, God

made two great lights — the greater light to rule the day — has suggested a difficulty which has greatly exercised the minds of many. Of its painful effect, Mr Sharon Turner, in his "Sacred History of the Creation," acknowledges himself in early life to have been an instance.

Efforts have not, however, been wanting to remove this difficulty. It has been said, for instance, that the element of light was created on the first day, but that on the fourth it was collected into the ruling orb; thenceforward to be its great and exhaustless depository. An analogy to this is found in the fact, that on the *second* day "God made the firmament, and divided the waters which were under the firmament from the waters which were above the firmament;" while it was on the *day following* that he said, "Let the waters under the heaven be gathered together *into one place*," Gen. i. 7. 9.

But another method of meeting the difficulty may be considered more satisfactory. If, according to the theory now generally adopted, light be not a substance, but only a series of vibrations of ether, or an effect produced as a subtile fluid by the excitement of one or many extraneous causes, "it can hardly be said," says Dr. Buckland, "nor is it said in Genesis i. 3, to have



NEBULÆ.

been created, though it may be literally said to be called into action."

Astronomy has shown that what is called nebulous matter, of which the figures given are, in a few instances, representations, exists in vast abundance in space. Multitudes of such spots are to be seen on the clear vault of heaven. In a paper read before the Royal Society in 1833, Sir John Herschel gives the places of 2500 nebulæ and clusters of stars. Of these, 500 are new; the rest he states, with peculiar pleasure, to have been accurately determined by his father. "This work," says Mrs. Somerville, "is the more extraordinary, as from bad weather, fogs, twilight, and moonlight, these shadowy appearances are not visible, on an average, above thirty nights in the year."

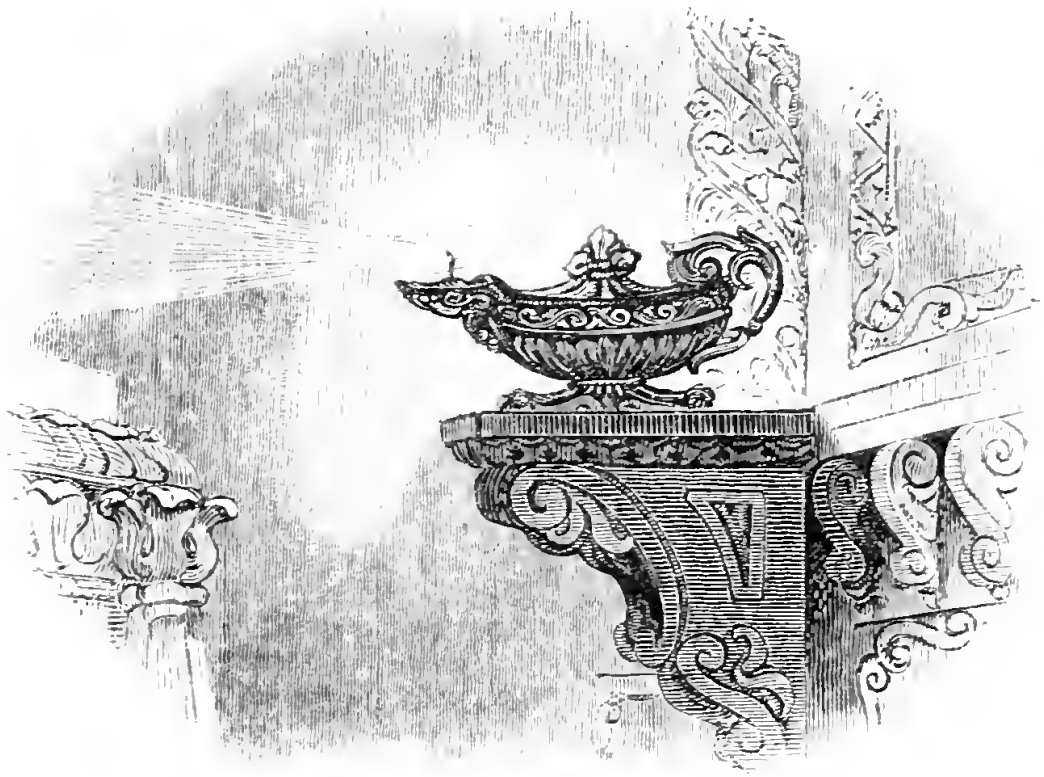
Now it appears highly probable that the Creator first formed luminous bodies in the heavens as a diffused and expanded element — a luminous, material substance, in a highly gaseous state; and that afterwards they were condensed into the regular forms presented to the eye. These nebulæ are now generally thought to pass through certain changes, until after appearing as expanded masses of faint light, they assume the shape and splendour of fixed stars. And what, in fact, is the great ruling orb? A star of the same nature as the rest; and

if so, having most probably the same origin; being at first a thin luminous fluid, and afterwards, by that law to which such bodies are subject, the glorious object from which nature, both animate and inanimate, derives so varied and extensive an influence.

Most interesting and remarkable is this coincidence, and it is only one of a multitude, in which modern science illustrates the sacred page of revelation. Such facts should, therefore, be known. The simple believer in the word of God rests, indeed, with implicit confidence on the Divine testimony. It is enough for him that it was penned by the God of truth. But even in *his* experience, there may be times of doubt, — times in which there are the reasonings of unbelief; and still more, times of Satanic suggestion: well, therefore, is it when he possesses the means of triumph. Nor should it be overlooked, that there are men who dare to impugn the testimony of Moses, while they revere that of Buckland, Herschel, or Whewell: and even *they* may feel that they are on a quicksand, when they know that these masters of modern science submit promptly and gratefully to the Jewish historian, and discard from the number of *their* true followers the disciples of a sceptical philosophy.

In proceeding now to notice the general properties of

light, it is necessary to remark, that this element issues in all directions from every visible point of luminous bodies. A ray of light appears like a single line, and a pencil of rays is a collection of them apparently proceeding from any one point of such a body.



No substance is yet known that is either perfectly opaque, or perfectly transparent. Gold may actually be beaten so thin as to admit light, while the clearest crystal, and the purest air or water, stops or absorbs its

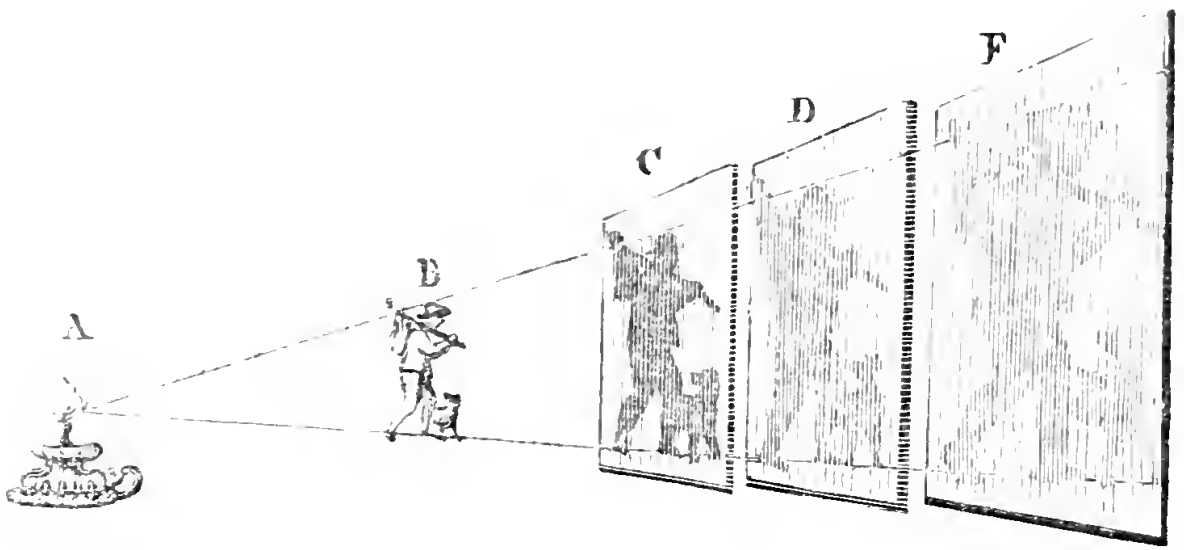
rays when transmitted, and gradually extinguishes them as they descend to greater depths. Objects cannot, therefore, be seen at the bottom of very deep water, and many more stars are visible to the naked eye from the tops of mountains than from the valleys. Still the terms opaque and transparent are sufficiently intelligible.

If, then, we hold a sheet of paper before a candle or the sun, it will be illuminated, provided that the light is not obstructed by an opaque body. Should it be otherwise, the interruption of the rays causes darkness on the opposite side; and if this darkness falls on a table, or any other object, it forms a shadow.

In describing his Winter Morning Walk, Cowper, referring to the sun, says:—

——————————— "His slanting ray
Slides ineffectual down the snowy vale,
And, tinging all with his own rosy hue,
From every herb and every spiry blade
Stretches a length of shadow o'er the field.
Mine, spindling into longitude immense,
In spite of gravity and sage remark,
That I myself am but a fleeting shade,
Provokes me to a smile. With eye askance,
I view the muscular proportioned limbs
Transformed to a lean shank. The shapeless pair,
As they designed to mock me, at my side
Take step for step; and, as I near approach
The cottage, walk along the plaster'd wall,
Preposterous sight! The legs without the man."

When the luminous body is larger than the opaque body, the shadow will gradually diminish in size, till it ends in a point. Such is the case with the shadows of



the earth and the moon, as the sun which shines on them is larger than either. But where the luminous body is less than the opaque, the shadows will increase according to the distance. All objects which are apparently larger than the sun cast therefore a magnified shadow. Thus the shadow of a figure B cast from the light A, varies in size with the distance of the surfaces C D E on which it is thrown.

The apparent depth of a shadow is not proportioned to its real darkness, but to the actual intensity of the surrounding lights. Even when the sun is veiled by clouds, a landscape may be very bright, and little or no shadow

may be perceived; but when the clouds have passed away, every projecting object casts behind it a deep shadow. Yet all appearing at that time so dark, are really more illuminated than before the shadow existed, for they receive and also scatter new light from all other objects around, now more fully lit up.

Another fact in connexion with light is, that it always proceeds in straight lines. A straight tube may be easily seen through, but not a crooked one. This experiment may easily be tried, while in some circumstances the result may be rendered more strikingly apparent. "If," says Dr. Arnott, "a person enter one end of the canal-tunnel, two miles long, which is cut through the chalk-hills near Rochester, to join the Thames and Medway rivers, the opening at the distant end is seen as a minute visible speck, having the form of the general arch, and appearing in the centre of the shade to an eye placed in the centre; and a person who has advanced half-way through the tunnel may see the luminous speck at each end, then appearing a little larger than in the former case."

The same fact is manifest from the form of shadows; their outlines being always that of the object as seen from the luminous body. Many a memorial of friendship and affection has in consequence been obtained by

tracing the shadow of some much-loved face on a wall; a process which is said to have given rise to the painting of profiles. One proof of the rotundity of the earth is derived during an eclipse of the moon, from our globe intercepting the sun's rays, and casting on it a spherical shadow.

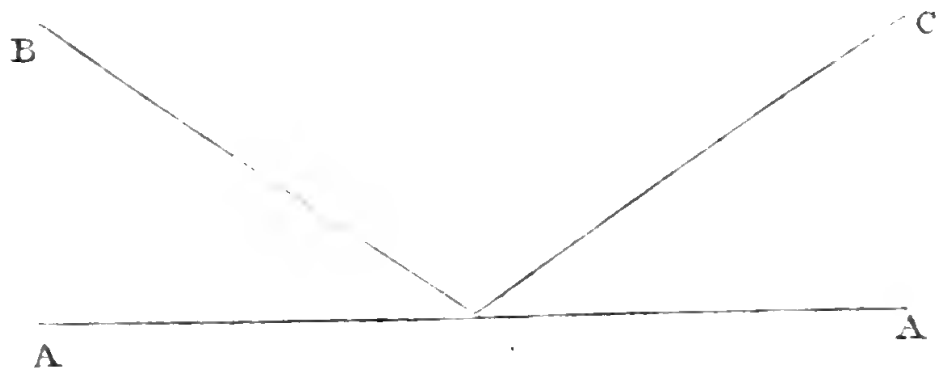
No sensible time is lost in various communications, from light requiring time to travel. A telegraph is so constructed as to assume different forms or appearances at the pleasure of an attendant, and to allow of the changes being distinguished at a distance. The most modern structure of this kind is called a Semaphore; it is a pole with moveable arms, each position standing for a letter, or a cipher; a word, or a sentence, as may be previously determined. By this means, a message may be sent from London to Portsmouth in a minute and a half; and at the same rate, a communication might be made to Constantinople, or any place more distant, with proportionate rapidity. But the passage of light is beyond all parallel. If two observers are placed at the distance of seventy or eighty miles, and if one of them strikes a light at a known instant of time, the light will travel to the other so swiftly that its flight cannot be measured by the nicest time-keepers. It has, however, been proved, by observing the eclipses of

Jupiter's satellites when that planet is nearest and farthest from the earth, that light travels from the sun to us in seven minutes. It will therefore move from the one pole of the earth to the other in the twenty-fourth part of a second, or at the rate of 190,000 miles in that inconsiderable space of time. So amazing is its velocity, that the earth, moving at the rate of nineteen miles in a second, would take two months to pass through a distance which a ray of light would dart over in eight minutes.

CHAPTER V.

BURNING MIRRORS — SINGULAR ILLUSIONS — SCIENCE AN ANTIDOTE TO SUPERSTITION — THE LIGHT OF TRUTH INVALUABLE.

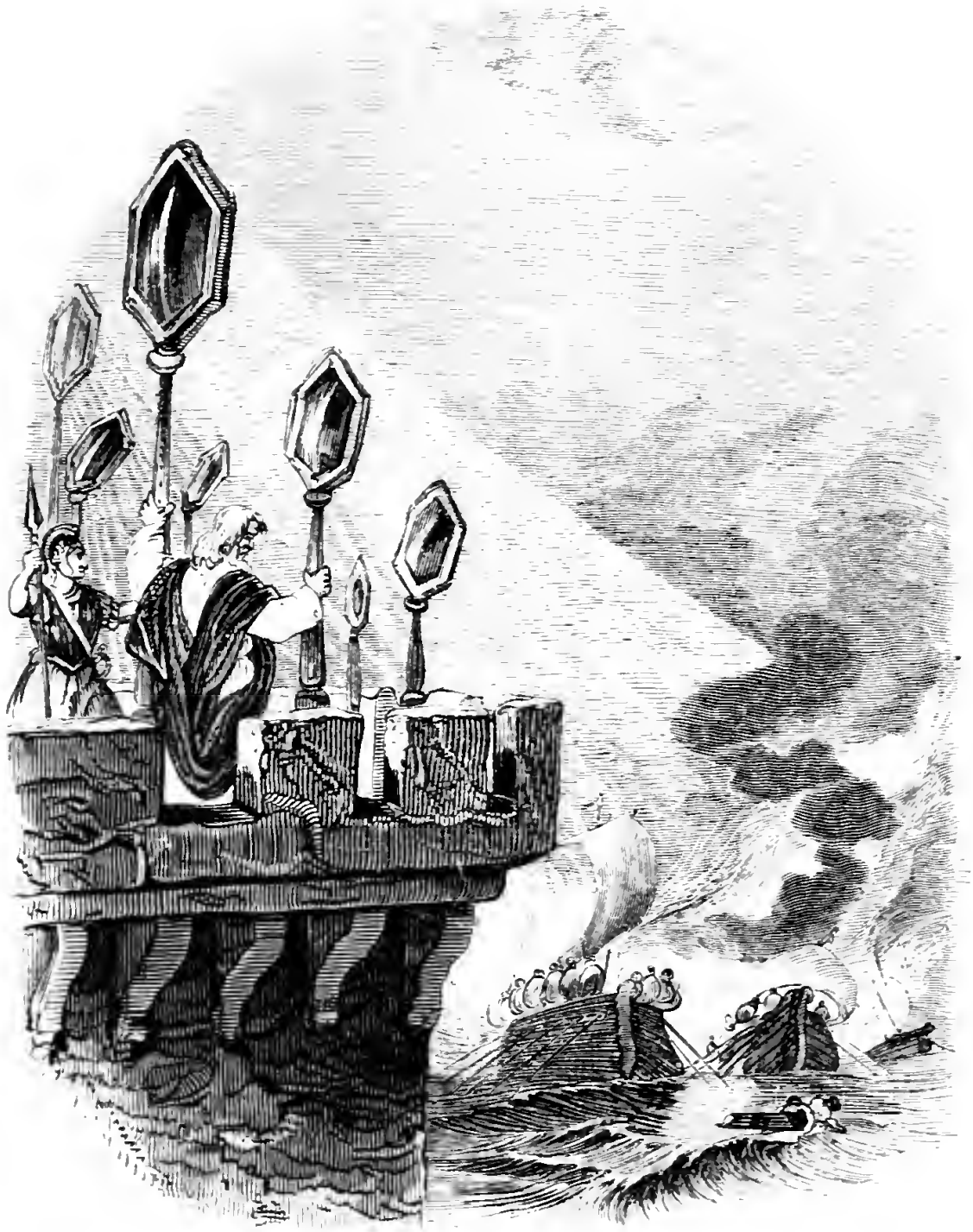
SOME knowledge of optics was possessed in very early times. As the ancients discovered that vision is performed in straight lines, they directed their attention to them, and found that when a ray of light falls obliquely on a bright surface it is reflected, and that the angle of reflection is equal to the angle of incidence.



Let A A in the above figure be a bright surface, B the ray of light falling obliquely on it, and C the reflected ray: in this case, it is apparent that the angle

B A is equal to the angle C A. From this knowledge was derived the art of perspective, or that of designing on a plane the representations of various objects, as they would appear to the eye from a given point;—an art which was re-invented about the end of the fifteenth century.

The ancients seem also to have been conversant with the laws of the reflection of objects from the surface of water and polished metals. The earliest application of their knowledge in this way with which we are acquainted is that of the burning mirrors employed by Archimedes, a philosopher of Syracuse, about two hundred years before the Christian era. At the siege of that city by Marcellus, the Roman consul, he employed them to destroy the navy of the assailant. The method he adopted is thus described by the historian Tzetzes:—"When the fleet of Marcellus was within bow-shot, the old man, Archimedes, brought an hexagonal mirror, which he had previously prepared, at a proper distance from which he also placed other smaller mirrors of the same kind, that moved in all directions on hinges, which, when placed in the sun's rays, directed them upon the Roman fleet, whereby it was reduced to ashes." We are also informed that Proclus in the same way destroyed the fleet of Vitellius, at the siege of Byzantium.



BURNING MIRRORS OF ARCHIMEDES.

To explain a phrase which must presently be used, it may be remarked, that the term *focus* is Latin, and literally means a fire-place: it is therefore appropriately employed to denote that point where the rays of the sun are concentrated by a mirror; and hence when focal distance is mentioned, it will be at once intelligible.

The power of mirrors of a large diameter has been fully proved in later times. By these instruments the hardest metals, on which common fires, and even glass-house furnaces, could produce no effect, have been melted in a few seconds. M. Vilette, a Frenchman, nearly a century ago, constructed a mirror three feet eleven inches in diameter, and three feet two inches in focal distance, which melted *copper ore* in eight seconds, a fish's tooth in thirty-two seconds, *iron ore* in twenty-four seconds, cast iron in sixteen seconds, a silver sixpence in seven seconds, and *tin* in three seconds. This mirror condensed the solar rays 17,257 times; a degree of heat which is about *four hundred and ninety times* greater than that of a common fire.

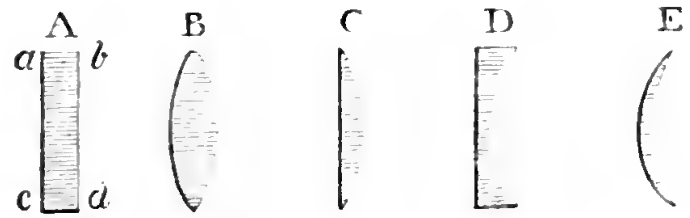
Mr. Parker, of London, also constructed a lens three feet in diameter, and six feet eight inches focus, which weighed 212 pounds. It melted twenty grains of gold in four seconds, and ten grains of platina in three seconds. The broader the mirror or lens, and the shorter the

focal distance, the more intense is the heat produced by such instruments. A globular decanter of water makes a powerful burning-glass; and household furniture has been set on fire by incautiously exposing it to the rays of the sun.

Count Buffon, too, formed a burning mirror of 168 small ones, each six inches square. By means of this instrument, with the faint rays of the sun in the month of March, he set on fire boards of beech wood at 150 feet distance. At another time, he burnt wood at the distance of more than 120 feet, and silver was fused at 50 feet.

Any substance of a regular form which is used to reflect light, or to exhibit images of objects, is called a speculum or mirror. The latter name is commonly given to reflectors made of glass, which have quicksilver on the back, that they may reflect more light. The former name is applied to a metallic reflector.

A *plane* speculum or mirror, as A, has two plane surfaces, a b, c d, parallel to each other. A *double convex* one, shown at B, is a solid formed by two convex spherical surfaces, having their centres on opposite sides. A *plane convex*, represented at C, has one of its surfaces convex and the other plane. A *plane concave*,



described at D, has one surface concave and the other plane. A *meniscus*, which appears at E, has one surface convex, and the other concave; the two meeting if continued. The same description applies equally to lenses.

Mirrors were used in ancient times to produce illusion. An observer in front of a plane mirror sees a distinct image of himself; but if two persons take up a mirror, one standing as much on one side of a line perpendicular to the middle of it, as the other is on the other side, they will see each other, not themselves. This has been called the magician's mirror, and by some contrivances has been made to produce great surprise.

The wonder is, however, sometimes increased in other circumstances. A visitor to "the Gallery of Practical Science" may observe, for instance, at the end of the Long Room, what is called a "Phantom Box." He will see an opening, into which he may thrust his arm; but if he retires a few paces, he will

perceive a goldfinch sitting on a branch; while this disappears as the aperture is approached. This singular effect is produced by a concave mirror at some distance behind, with this object placed before it in an inverted position. On this a strong light is cast, and the rays being prevented from reaching the opening, the figure is thrown into the aperture.

A still more striking effect has been produced by the same means. The spectator sees, in this case, a basket of fruit, of which he is asked to partake; but as he approaches for that purpose, a person properly concealed withdraws the real basket of fruit, and with the other hand advances a dagger, the image of which is not a little alarming.

It was by such contrivances that superstition obtained great power in former times. These effects, known but to a few, served to lead in bondage the many. We read even of Hercules appearing in the ancient temple at Tyre, of Æsculapius showing himself in another at Tarsus, and of a third edifice in Sicily, famous for exhibiting the goddesses to mortals. But in these instances optical illusions were no doubt used, and often in connexion with living objects.

There is reason to rejoice that the days of such

deceptions have passed away. Many a sight, which has struck terror into the ignorant, has been shown to be as free from any just means of exciting alarm, as the white sign-post which has been conjured into a ghost. Many an object of wonder to the partially informed has been easily explained by a larger amount of knowledge. "Within the last forty years," says Sir David Brewster, "science has brought these atmospherical spectres within the circle of her dominion; and not only are all their phenomena susceptible of distinct explanation, but we can even reproduce them on a small scale with the simplest elements of our optical apparatus."

But not only have we the light of Science; there is one unspeakably more valuable, the light of Divine truth. It was a distinguished privilege of the Apostle Peter, to behold the transfiguration of Christ, and to hear a voice from the excellent glory, saying: "This is my beloved Son, in whom I am well pleased," Matt. iii. 17. And this, it might be supposed, was not to be surpassed. But he distinctly declares that it is; and *that* in the experience of the peasant or the child who is the possessor of the Holy Scriptures. "We have," he says, "a more sure word of prophecy; whereunto ye do well that ye take heed, as unto a light that shineth in a dark

place, until the day dawn, and the day star arise in your hearts," 2 Pet. i. 19. Most truly does the poet Cowper sing: —

"A glory gilds the sacred page,
Majestic, like the sun:
It gives a light to every age,
It gives, but borrows none.

The hand that gave thee still supplies
The gracious light and heat;
His truths upon the nations rise:
They rise, but never set.

Let everlasting thanks be thine,
For such a bright display,
As makes a world of darkness shine
With beams of heavenly day."

Nor should we fail to adopt the language of the Psalmist: "Thy word is a lamp unto my feet, and a light unto my path," Psa. cxix. 105. Like him, too, we must look to God as our teacher. "The natural man receiveth not the things of the Spirit of God: for they are foolishness unto him: neither can he know them, because they are spiritually discerned," 1 Cor. ii. 14. "God hath revealed them," says that apostle whose words have just been quoted, "unto us by his Spirit: for the Spirit searcheth all things, yea, the deep things of God," 1 Cor. ii. 10. Whenever we open the Scriptures, there-

fore, his gracious influence should be sought; without this they will be wrapped in darkness; but with it, in the light of God we shall see light, Psa. xxxvi. 9.

To return now to natural objects. The reflection of light is of common occurrence. For when its rays encounter an opaque body, which they cannot traverse, some of them are absorbed by it, but others are reflected, and rebound like an elastic ball when it is struck against a wall. It is by reflected rays alone that we see opaque objects. Luminous bodies send rays of light immediately to our eyes; but the rays which they transmit to other bodies are invisible to us, and are beheld only when they are reflected to our eyes by those bodies.

If we look at a large sheet of water at noonday, the sun will appear to shine on only one part of it, though the whole is equally exposed to its beams; and at night, a vivid streak of moonshine may be observed on the sea, though no obstacle appears to prevent the moon from shining equally on every part of the water; and the cause is, that the rays which fall with various degrees of obliquity on the water are reflected in directions equally various; some of these will meet the eyes, and will therefore be seen, but those which fall elsewhere will be invisible. The objects which are illumined by reflected rays, and those which receive direct

rays from the sun, but do not reflect them towards us, appear equally in shadow.

It seems very probable that the blue appearance of the heavens is to be accounted for by reflection, since we look at a dark vacuity, beyond the atmosphere, through an illuminated medium. Were there no atmosphere, it is generally admitted that the appearance would be perfectly black, except in the particular direction of the sun, or some other heavenly body; and since the atmosphere is transparent, this blackness, if so it may be called, must be seen through it, only somewhat modified by the rays of light reflected by the atmosphere to the eye, from the direction in which we are looking. For this reason, the clearer or more transparent the atmosphere is, the darker is the appearance of the heavens; there is then less light reflected by the atmosphere to the eye. In the zenith, that is, the point over-head, the appearance is always darker than nearer the horizon; and from the tops of high mountains, the heavens in the zenith appear nearly black.

To allude to one other circumstance in connexion with the firmament; every one is acquainted with the twinkling of the stars, but the cause of this appearance is known only to few. Yet it is a familiar fact, that if a person take a stick, lighted at one end, and cause this

part to revolve swiftly, there will appear to be a continued circle of light. If the lighted end be made to revolve more slowly, or if the circle be increased in size, this may be made to appear much brighter on one side than on the other, or it may appear bright on one side, and entirely broken on the other.

Now to this there is a resemblance in the twinkling of the stars, and the deception in the number of them visible to the naked eye in a clear evening. As a fixed star has no visible diameter, only one stream of the rays of light proceeding from it can enter the eye; and since the fixed stars are at such an immense distance, the particles of light from one of them that would fall in so small a surface as the pupil of the eye, must be at a considerable distance from each other. When, therefore, a particle of light from a fixed star falls on the eye, it produces a vivid impression; and this gradually becomes dimmer, until another particle arrives, producing another vivid impression.

This, then, causes the twinkling. In the case of the lighted stick, the circle is unbroken: another particle arrives before the impression made by the former one has entirely vanished. But the particles of light which proceed from more distant stars fall on the eye at too great intervals to keep up a continued image. Hence,

when a particle of light from one of them falls on the eye, it produces a perception of a star; but when we endeavour to contemplate this star, it is invisible, because the image formed has vanished, and another particle has not yet arrived to renew it. In this way we are led to suppose there are more stars visible than on examination we find.

The only cause why telescopes enable us to see stars that are invisible to the naked eye is, that they concentrate the rays from so large a surface as to keep up a continued image of the star.

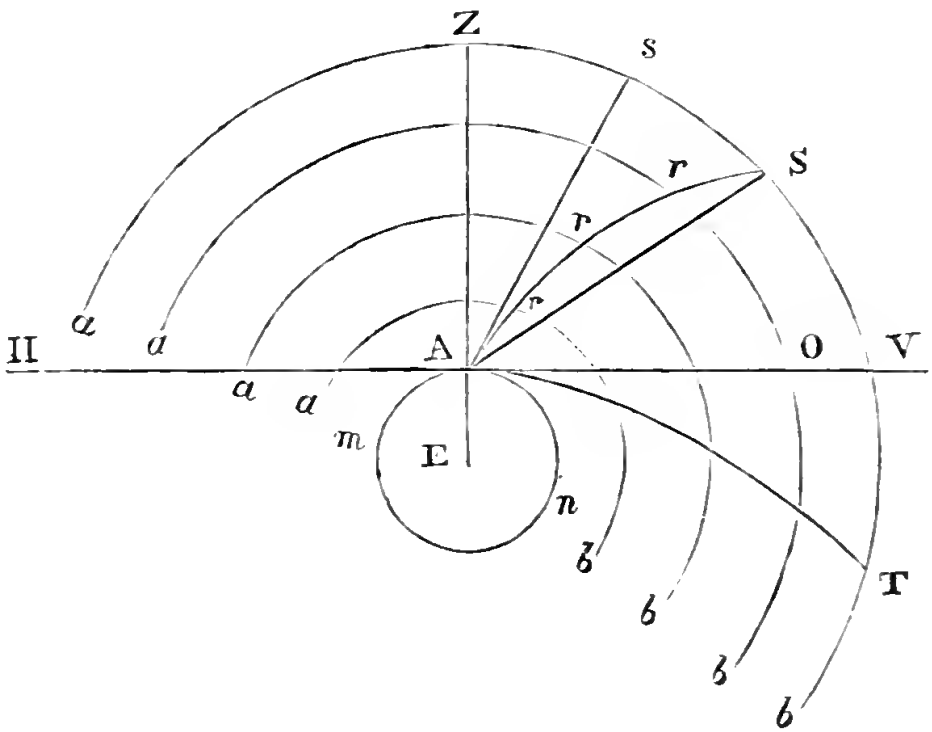
CHAPTER VI.

THE ATMOSPHERE—ITS REFRACTIVE POWER—SPECTRAL APPEARANCES.

We see, as well as hear, through the medium of the atmosphere. A knowledge of its action on light is therefore necessary; and, in the absence of this, many and great errors will arise. Without it, neither the exact place of very distant objects on the surface of the earth, nor the position of the heavenly bodies, can be determined.

All these luminaries appear more elevated than they actually are; because the rays of light, instead of moving in straight lines, are bent by the atmosphere towards the earth. Let, for example, *a b*, *a b*, *a b*, *a b*, in the following figure, be strata, or very thin layers of the atmosphere, which increase in density towards *m n*, the surface of the earth. A ray coming from a star meeting the surface of the atmosphere at S, would be refracted, or bent at the surface of each layer, and would consequently move in the curved line S *r r r* A;

and as an object is seen in the direction of the ray that meets the eye, the star which actually is in the direction



A S, would seem to a person at A to be in s. This refraction, which always acts in a vertical direction, raises objects above their true place; and for this reason, a body at T, below the horizon H A O, would be raised, and seen in V.

To the refractive power of the atmosphere it is owing, that the sun is visible before he rises above the horizon in the morning, and after he sinks beneath it in the evening; and that we sometimes see the moon on her rising totally eclipsed, while the sun is still apparent in the opposite part of the horizon.

The same effect appears in other cases. If a ray of light falls on a drop of water, a piece of glass, or a bottle containing a transparent fluid, it does not reach the eye as it would if no object had been placed in its way. In these, and all similar circumstances, light is refracted, or diverted from its direct course by the body which is thus interposed. Of this a simple illustration may be given.

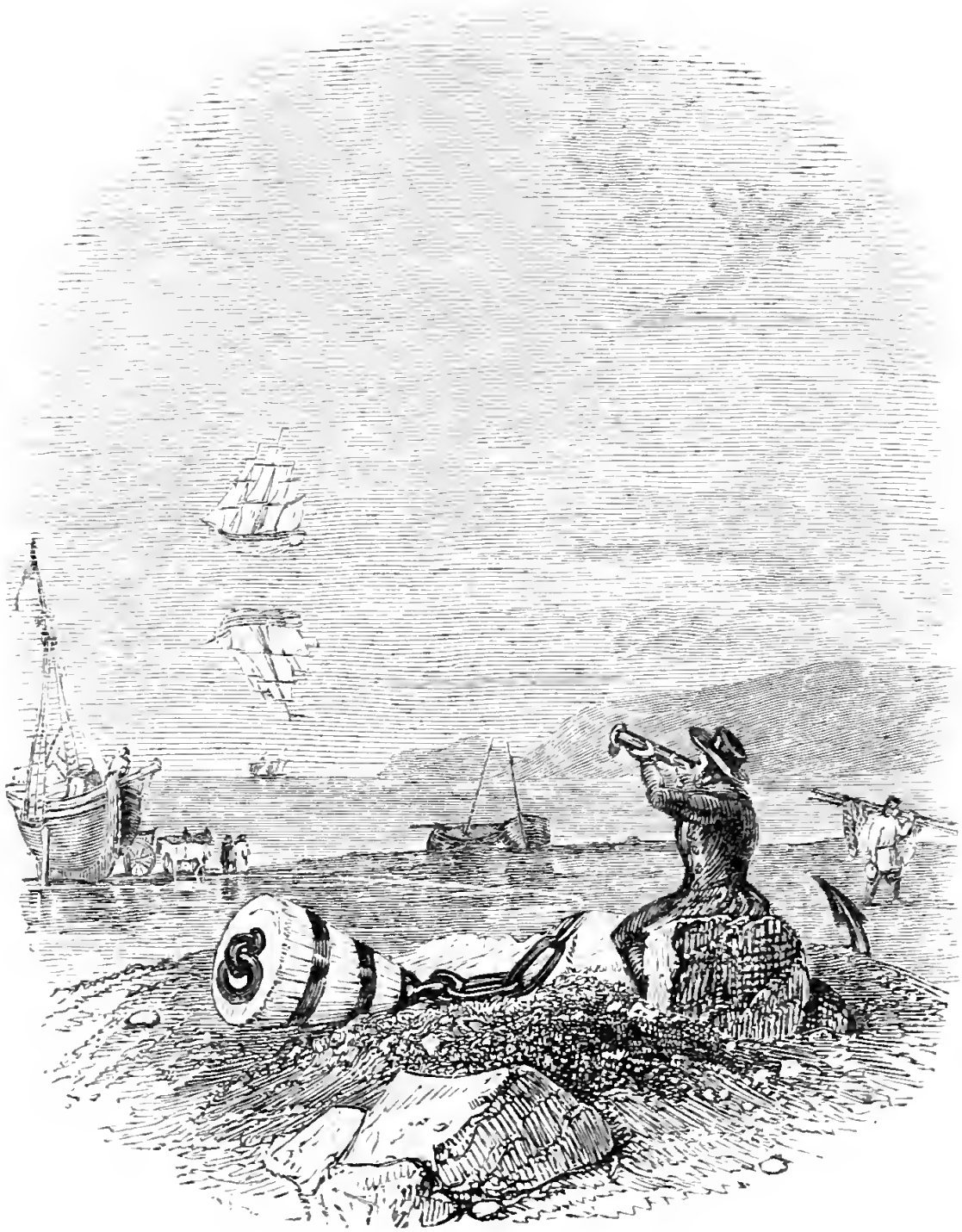
If, for instance, you put a cup, having a flower painted at the bottom of the inside, on a table, to stand at such a distance as that the flower may be concealed by the rim, and if any person will pour water into the cup, you will soon see the flower, though you do not move. The reason is, because when you removed so far that the flower was hidden by the rim, the rays reflected by it no longer met your eyes; but when the cup was filled with water, the water refracted, or bent them downwards, so as to render the object visible.

It is here, however, to be particularly observed, that when the flower becomes visible by the refraction of the ray, you do not see it in its real situation, but you behold an image of the flower *higher up* in the cup; for, as objects always appear to be situated in the direction of the rays that enter the eye, the flower will be seen in the direction of the *refracted ray*. Before the

water was poured in, the flower could not be seen *where it was*, now it is seen *where it is not;* for as it is in a denser medium, it appears raised, or nearer to the surface.

To this circumstance it is owing, that an oar, partly in and partly out of the water, appears crooked; that a fish seems much nearer the surface of the stream than it actually is; and that pools and rivers appear shallower than they really are, so that if eight feet deep, they will seem to be but six. From ignorance or forgetfulness of this fact, many a school-boy and many a traveller have lost their lives. The only way to judge of the depth of water accurately, is to view it from a boat, so that it may be looked down upon perpendicularly; when the rays rising perpendicularly from the bottom, no refraction will take place.

To return now to the flower in the cup. If *salt* water be poured in instead of fresh, the ray will be more bent; alcohol would refract it more than salt water, and oil more than alcohol; thus different bodies refract light in different degrees. A table of their varied power may be easily found in large works on this subject. It follows from the circumstances thus illustrated, that certain states of the atmosphere, depending on warmth, humidity, or other causes, greatly affect its ordinary



SPECTRAL ILLUSION.

refractive power; so that a certain hill which at one time appears low, may, at another, be seen towering aloft. In like manner, a city, in a neighbouring valley, may, from a certain station, be entirely visible; or it may show only the tops of its buildings, just as if its foundations had sunk deeper into the earth.

A traveller, when on the summit of Mount Etna, observed, at the extremity of the vast shadow which it projects across the island, a perfect image of the mountain, elevated above the horizon, and diminished, as if viewed in a concave mirror. The effect was observed not only by him, but by his whole party, and filled them with great surprise, though beforehand prepared for it by their Catanian friends. Here is one example of refractive power.

Dr. Vince, also, observed at Ramsgate a ship, whose top-masts only were seen above the horizon; but he at the same time saw, in the field of the telescope through which he was looking, two images of the complete ship, in the air, both directly above the ship, the uppermost of the two being erect, and the other inverted.

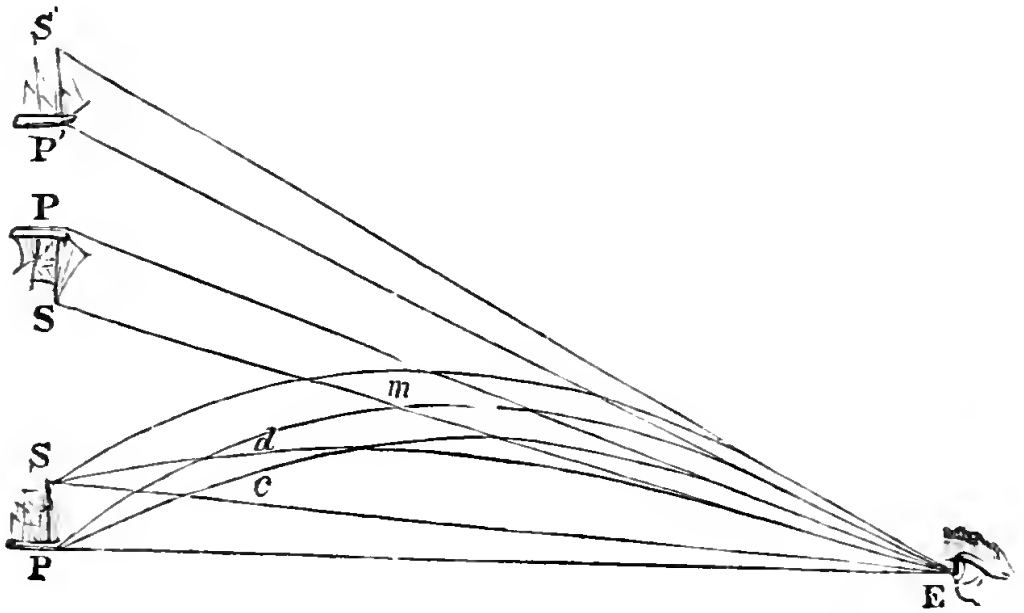
Dr. Vince then directed his telescope to another ship, whose hull was just in the horizon, and he observed a complete inverted image of it; the mainmast of which just touched the mainmast of the ship itself.

On looking at another, he saw inverted images of some of its parts, which suddenly became visible and vanished: "first appearing," he says, "below, and running up very rapidly, showing more or less of the masts at different times, as they broke out; resembling, in the swiftness of their breaking out, the shooting of a beam of the aurora borealis." As the ship continued to descend, more of the image gradually appeared, till that of the whole ship was at last completed, with the mainmasts in contact. When the ship descended still lower, the image receded from the ship, but no second image was seen.

Dr. Vince observed another case. Here the sea was distinctly visible between the ships. As the ship rose above the horizon, one image gradually disappeared, and, during this time, the other image descended, but the ship did not seem so near the horizon as to bring the mainmasts together. The two images were visible when the whole ship was beneath the horizon.

Another remarkable fact, to be accounted for in the same manner, is related by Captain Scoresby. His ship, when in the polar sea, had been separated by the ice from that of his father for some time, and he was looking out for her every day with great anxiety. At length, one evening, to his utter astonishment, he saw her

suspended in the air, in an inverted position, traced on the horizon in the clearest colours, and with the most distinct and perfect representation. He sailed in the direction in which he saw this visionary phenomenon, and actually found his father's vessel by its indication. He was divided from the ship by immense masses of icebergs, and at such a distance that it was impossible to have seen her in her actual situation, or to have seen her at all, if her spectrum had not been thus raised several degrees above the horizon into the air by this most extraordinary refraction.



In the figure, such a phenomenon is represented. S P is a real ship, with its inverted and direct images as seen in the air. Without refraction, the rays would

come from the ship S P to the eye E in the direction of the straight lines; but from the variable density of the inferior strata of the atmosphere, the rays are bent in the curved lines P *c* E, P *d* E, S *m* E. The point P of the real ship is therefore seen at P and P′, and the point S seems to be in S and S′, and as all other points are transferred in the same manner, direct and inverted images of the ship are formed in the air.

To illustrate still further this fact, Dr. Wollaston performed the experiment represented above. He poured into a square phial a small quantity of clear *syrup*, and above this he poured an equal quantity of *water*, which gradually combined with the syrup, as seen at A. The word "Syrup," on a card held behind the bottle appeared

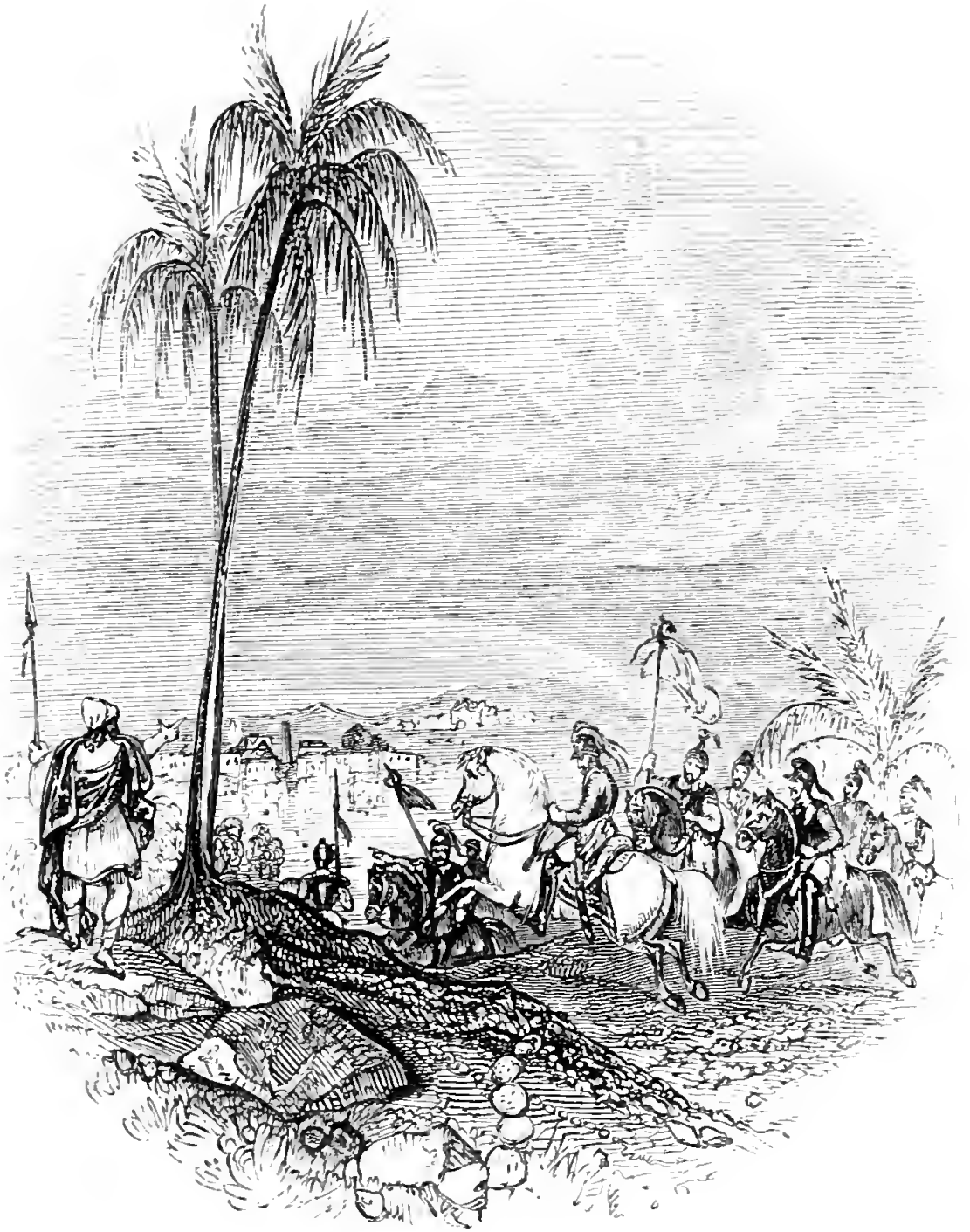
erect when seen through the pure syrup, but inverted, as represented in the figure, when seen through the mixture of water and syrup. Dr. Wollaston afterwards put nearly the same quantity of rectified spirits of wine above the water, as seen in the same figure at B, and he saw the appearance there represented, the true place of the word "Spirit," and the inverted and erect images below. Another of his experiments had a similar result. He looked along a red-hot poker at a distant object, and two images were seen; one erect and the other inverted, in consequence of the change produced by the heat in the density of the air.

A member of the National Institute accompanied the French army in Egypt. In the desert between Alexandria and Cairo, he and a party saw in all directions green islands, surrounded by extensive lakes of pure, transparent water. Nothing could be conceived more lovely or picturesque than this landscape. In the tranquil surface of the lakes, the trees and houses with which the islands were covered were strongly reflected with vivid and varied hues, and the party hastened forward to enjoy the refreshments proffered them. But when they arrived, the lake, the trees, and the people who stood on the shore inviting their approach, had all vanished; and nothing remained but a uniform and

irksome desert of sand and sky, with a few naked huts and ragged Arabs. But for being undeceived by their approach, one and all would have united to declare that these visionary trees and lakes had a real existence in the midst of the desert.

The appearance of water so well known to travellers in Africa, and to the Arabs of the desert on the lake of the Gazelles, is traced by Mrs. Somerville to the reflection which takes place between strata of air of different densities. The mirage described by Captain Mundy, in his journal of a Tour in India, has also been supposed to arise from the same cause. "A deep precipitous valley," he says, "below us, at the bottom of which I had seen one or two miserable villages in the morning, bore in the evening a complete resemblance to a beautiful lake; the vapour, which played the part of water, ascending nearly half-way up the sides of the vale, and on its bright surface trees and rocks being distinctly reflected. I had not been long contemplating the phenomenon, before a sudden storm came on and dropped a curtain of clouds over the scene."

Another extraordinary spectacle occurs, under certain circumstances, at the Pharo of Messina, in Sicily. To enjoy it, the spectator must stand with his back to the



LANDSCAPE IN THE DESERT.

east, on an elevated place behind the city, commanding a view of the bay, and having the mountains, like a wall, opposite to him, to darken the back-ground of the picture. No wind must be abroad to ruffle the surface of the sea; and the waters must be pressed up by currents, as they sometimes are, to a considerable height in the middle of the strait, so that they may present a slight convex surface. When all these circumstances concur, as soon as the sun rises over the heights of the Calabrian shore and makes an angle of 45 degrees with the horizon, all the objects on the shore at Reggio are transferred to the middle of the strait, and seen distinctly on the surface of the water, forming an immoveable landscape of rocks, trees, and houses, and a moveable one of men, horses, and cattle; and these are formed into a thousand separate compartments, presenting most beautiful and ever-varying pictures of animate and inanimate nature, as the swelling surface of the water, broken by the currents, presents separate plates of convex mirrors to reflect them; they then as suddenly disappear. It is also observable, that if, while these objects are visible, the atmosphere is charged with vapour or dense exhalations, the phenomena apparent on the water will also be visible in the air, occupying a

space which extends from the surface to the height of twenty-five feet. Such images, however, will not be so distinct as the former.

In December, 1826, a great sensation was produced in France by the following circumstance. On a Sunday, the clergy of the parish of Migné, in the neighbourhood of Poitiers, were engaged in the exercises of the jubilee, which preceded the festival of Christmas, and about 3000 persons from all the neighbouring parishes attended the service. At five o'clock in the evening, one of the preachers was addressing the multitude, and reminding them of the cross which appeared in the sky to Constantine and his army, when suddenly a similar cross appeared in the heavens, just before the porch of the church, about 200 feet above the horizon, and 140 feet in length, of a bright silver colour tinged with red, and perfectly well defined. Such was the effect of this appearance, that all the people threw themselves on their knees, and united together in one of their canticles.

The fact was, that a large wooden cross, 25 feet high, had been erected beside the church as a part of the ceremony. In a state of the atmosphere peculiarly favourable, the figure of this was formed and reflected back to the eyes of the spectators, retaining exactly the

same shape and proportions, but changed in position and dilated in size; it was, moreover, tinged with red, the very colour of the object of which it was the reflected image. When the rays of the sun were withdrawn, the image disappeared. A mist, or a fog, is often said to magnify objects seen through it, when the fact is, that it conveys this idea, by making them appear further distant than they actually are. A bush may thus be mistaken for a tree, and a man of ordinary size may be confounded with one of gigantic stature. The painter acts on this principle when he wishes to give the effect of distant objects, by using for them sombre colours.

Extraordinary stories were once told of the gigantic figure of a man, which was often observed walking on a certain ridge of the Hartz mountains at sunrise. About forty years ago, a French philosopher, attended by a friend, went to watch this spectre, but for many mornings they traversed an opposite ridge in vain. At length, however, it was discovered, having also a companion; and, singularly enough, these two figures imitated all the motions of the philosopher and his friend. For the fact was obvious: the spectres were merely their shadows, formed by the horizontal rays of the sun, when rising, falling on the fog which hovered

over the valley beyond. As such shadows were very faint, they were considered distant, and therefore seemed men walking on the opposite ridge; and because a comparatively small figure seen near, but supposed to be distant, appears of gigantic size, these shadows were accounted giants.

Dr. Buchan mentions a similar effect. "Walking on the cliff," he says, "about a mile to the east of Brighton, on the morning of the 18th of November, 1804, while watching the rising of the sun, I turned my eyes directly towards the sea, just as the solar disc emerged from the surface of the water, and saw the face of the cliff on which I was standing represented precisely opposite to me at some distance from the ocean. Calling the attention of my companion to this appearance, we soon also discovered *our own figures* standing on the summit of the opposite apparent cliff, as well as the representation of a windmill near at hand. The reflected images were most distinct precisely opposite to where we stood, and the false cliff seemed to fade away, and to draw near to the real one, in proportion as it receded towards the west. This phenomenon lasted about ten minutes, till the sun had risen nearly his own diameter above the sea. The whole then seemed to be elevated into the air, and successively disappeared.

The surface of the sea was covered with a dense fog of many yards in height, which gradually receded before the rays of the sun."

It is hoped that the explanation now given will not only satisfy the mind as to the phenomena described, but that it will prevent any erroneous impression in reference to others of a similar kind.

CHAPTER VII.

COLOURS—THE RAINBOW—VISION OF JOHN IN PATMOS.

We are little aware, until engaged in serious reflection, how great a difference would arise were only one alteration made in the arrangements of the great Creator. Had, for instance, a white light fallen on the objects around us, and had they been equally acted upon by the bodies on which they fall, all the objects of the material world would then have had a leaden hue. In this case, it has been truly said, all the features of the human countenance would have presented no other variety than they have in a pencil sketch or a China ink drawing; the rainbow would have dwindled into a narrow arch of white light; the stars would have shone through a grey sky, and the mantle of a wintry twilight would have replaced the golden robe of the setting sun.

A curious illustration of this fact will appear in illuminating objects with light of one colour. If we cast a pure and unmixed yellow light on scarlet cloth, it will appear yellow, because the scarlet cloth does not absorb

all the yellow rays, but reflects some of them; and if we illuminate blue cloth with yellow light, it will appear nearly black, because it absorbs nearly all the yellow light, and reflects scarcely any of it. But whatever be the nature and colour of the bodies on which the yellow light falls, the light which it reflects must be yellow, since they have no other light; and those which are not capable of reflecting yellow light must appear absolutely black, however brilliant be their colour in the light of day.

It has been long known, that salt thrown into the wick of a flame produces yellow light; but this is mixed with blue and green rays, and is, besides, small in quantity. An apparatus has therefore been constructed for a curious experiment, and the effect is thus described by Sir David Brewster:—"Having obtained the means of illuminating any apartment with yellow light, let the exhibition be made in a room with furniture of various bright colours, and with oil or water-coloured paintings on the wall. The party which is to witness the experiment should be dressed in a diversity of the gayest colours; and the brightest coloured flowers and highly coloured drawings should be placed on the tables. The room being at first lighted with ordinary lights, the bright and gay colours of every thing that it contains will be finely

displayed. If the white lights are now suddenly extinguished, and the yellow lamps lighted, the most appalling metamorphosis will be exhibited. The astonished individuals will no longer be able to recognize each other. All the furniture in the room, and all the objects which it contains, will exhibit only one colour. The flowers will lose their hues; the paintings and drawings will appear as if they were executed in China ink; and the gayest dresses, the brightest scarlets, the purest lilacs, the richest blues, and the most vivid greens, will all be converted into one monotonous yellow. The complexions of the parties too will suffer a corresponding change. One pallid, death-like yellow,

> ——————'Like the unnatural hue
> Which autumn paints upon the perished leaf,'

will envelope the young and the old, and the sallow face will alone escape from the metamorphosis. Each individual derives merriment from the cadaverous appearance of his neighbour, without being sensible that he is one of the ghastly assemblage."

Had there been light without the distinction of colours, objects could only have been distinguished by circumstances of time, place, or relative position; or by intricate trains of reasoning. To what perplexities and

delays should we then have been reduced! That which can now be done easily and at once, would then, if it could be accomplished at all, have resulted from a long and laborious process. Life would have been spent in thought rather than action. No aid could have been derived from the historians of the past, nor could the Divine word have been penned. The arrangement that there should be divers colours calls aloud, therefore, for the offering of our gratitude to God.

To this we are indebted for a large portion of the beauties of the natural world.

> "What white can match the lily's virgin snows?
> What red, the crimson of the blushing rose?
> What regal purple with the scabious vie?
> Or scarlet match the poppy's flaming dye?
> What yellow, lovely as the golden morn,
> The lupine and the heliotrope adorn!
> How mix'd a hue the streaky tulip stains!
> How curious the carnation's marbled veins!
> Ethereal blue the silky violets wear!
> And all unite their sweets in mingling air."

The plumage of birds, so peculiar to their order of creation, is always a pleasing object to the sight as well as the touch; and remarkable alike for the delicacy and skill of its structure. In this land they present much to admire, yet far greater is the effect in those regions where birds of the richest hues cross the glades, and

troops of peacocks complete the charm of the scene, spreading their plumes to the brightest beams of the sun. The humming-birds of our cabinets fill us with admiration, yet they are far inferior to the same species in their native climes. Where can the choicest works of art exhibit hues like theirs?

Nor should we omit the insect world, or the gay decorations of many of the finny tribes. Let us take, for instance, the dolphin, one of the most beautiful of the inhabitants of the sea. When swimming in the water, its colours appear exceedingly rich and delicate. The head, breast, and upper part of the sides, vary from the hues of burnished steel to that of deep azure and mazarine blue, shading off towards the under parts in pea green and light yellow; the head-fins are sky blue; and those of the tail pale green, terminating in yellow.

Much that is interesting might here be stated in reference to the human complexion; for every one is more or less marked by its distinctive colour. The black prevails under the equator, and the dark copper colour under the tropics; from the tropic of Cancer to the seventeenth degree of north latitude may be successively discerned the olive, the brown, the fair, and the sanguine complexion; and of each of these there are

several tints or shades. Here is an indication of the influence of climate, which, under equal circumstances, will always produce the same, or nearly the same results.

The power of climate is indeed established by many facts. From the Baltic to the Mediterranean, different latitudes may be almost traced by varying shades of colour. From the same general stock, or from nations nearly resembling each other, are derived the fair German, the dark Frenchman, and the swarthy Spaniard and Sicilian. The south of Spain is distinguished by complexion from the north. The same observation may be applied to most of the other countries of Europe; and if extended beyond Europe, to the great nations of the East, it is applicable to Turkey, to Arabia, to Persia, and to China.

The inhabitants of Pekin are fair; those of Canton are nearly black. The Persians near the Caspian are amongst the fairest people in the world; but near the Gulf of Ormus they are of a dark olive. Similar differences of colour may be observed in the inhabitants of Arabia Petræa, Arabia Deserta, and Arabia Felix; in the first and second they are tawny, and the people of the third are as black as Ethiopians. In these ancient nations, colour seems to follow a regular progression from the equator.

But no example can have greater force than that of the Jews. Descended from one common stock, yet dispersed, in the fulfilment of the Divine declarations, throughout every country of the globe, they are marked with the colours of all people: they are fair in Britain and in Germany, brown in France and Turkey, swarthy in Spain and Portugal, and tawny or copper-coloured in Arabia and Egypt.

Malpighi, an eminent Italian physician of the last century, was the first person who discovered that the skin was divided into three parts: the cuticle, the true skin, and a certain substance situated between both, which he called the *rete mucosum*. Now it is on this that colour is dependant. The cuticle, when divided according to this discovery, is semitransparent; it has been found, too, that the cuticle of the blackest negro is of the same transparency and colour as that of the purest white; and hence the true skins of both being invariably the same, that the *rete mucosum* is the seat of colour.

Further experiments might be expected to throw still more light on this discovery. No other result can indeed appear, for the cuticle, from its transparency, must transmit the colour of the substance beneath it, in the same manner, though not in the same degree, as the cornea

transmits the colour of the iris of the eye. This transparency is easily observed in white people. It is seen in every blush; for no one can suppose that the cuticle becomes red as often as this happens: nor is it less evident in the veins, which are so easily discerned; for no one can imagine that the blue streaks constantly seen in the fairest complexions, are painted as it were on the surface of the upper skin. Thus then it is apparent, that on the *rete mucosum* depends the colour of the human body; or, in other words, that the *rete mucosum* being of a different colour in different inhabitants of the globe, and appearing through the cuticle, or upper surface of the skin, gives them that variety of appearance, by which we are so much struck when contemplating the human race.

In connexion with colours, another object cannot fail to be remembered. "Look," says the son of Sirach, "upon the rainbow, and praise him that made it: very beautiful it is in the brightness thereof: it compasseth the heavens with a glorious circle, and the hands of the Most High have bended it." The Hebrews used a word to denote it, which means the Bow of God, and the Greeks one which signifies the Daughter of Wonder.

The rainbow is produced by the action of drops of water on light; for it to be seen, there must therefore

be rain and sunshine. If, under these circumstances, the back be turned to the sun, the beautiful bow will be observed thrown on the opposite cloud in all the brightness and variety of its tints. Frequently there are two bows, or arches: an inner one, in which the colours are more vivid, and an outer one, in which they are paler. Each exhibits the same series of colours, as the image produced by the prism; but red is the uppermost colour in the interior, and violet in the exterior bow. What pledge could have been given more happy or satisfactory, that mankind shall be exempt from a future deluge? In order that the rainbow may appear, the clouds must be partial; hence the rainbow cannot be seen in connexion with an universal deluge from above. After the lapse of ages since it was thus given, we may say:—

"How glorious is thy girdle cast
O'er mountain, tower, and town,
Or mirror'd in the ocean vast,
A thousand fathoms down!

As fresh in yon horizon dark,
As young thy beauties seem,
As when the eagle from the ark
First sported in thy beam.

For, faithful to its sacred page,
Heaven still rebuilds thy span,
Nor lets the type grow pale with age,
That then spoke peace to man."

THE RAINBOW.

With this accords one of the visions with which the beloved disciple was favoured, Rev. iv. 3. Admitted into the immediate presence of God, he beheld a glorious throne, on which One sat, whom he did not attempt to describe. Here, then, was an emblem of the universal, absolute, and eternal dominion of Jehovah; and of his exaltation as the great Creator and Sovereign Lord of all creatures.

As throughout these visions there is an allusion to the Temple, its furniture, and services, the visible glory may have had some reference to that above the mercy-seat in the holy of holies: its being resplendent like the jasper, might be emblematical of the perfect purity and excellency of the Divine nature; and its colour like the red sardine stone, might represent his awful justice and fiery indignation. It is said, moreover, "there was a rainbow round about the throne, in sight like unto an emerald:" thus intimating that the holiness and justice of God, and all his dispensations as the Sovereign of the universe, had respect to his covenant of peace, with which they fully harmonized. It has been supposed, that as in this rainbow the soft green of the emerald was predominant, it might perhaps imply, that as the green relieves the eye which is fatigued and dazzled by some other colours, so the discovery

of God's mercy in the covenant of grace soothes and refreshes the mind, which might otherwise be dismayed by the glories of his power, justice, and holiness.

Many peculiar rainbows have been seen and described. One occurred when a cloud charged with rain was passing, which produced a darkness so dense that the surface of the water on which the observer was sailing was quite obscured at a little distance. When it first began to disperse, a bright luminous appearance, tinged with prismatic colours, was seen emerging from the obscurity. The voyager was near the European coast, and by degrees it formed a bright arch, the legs resting about 100 yards on each side of him, and the apex on the other shore. Unlike other rainbows, it was perfectly horizontal, and lay flat on the water, to which it communicated a very beautiful and extraordinary aspect. It exactly resembled a brilliant rainbow suddenly cast down from the sky, and laid prostrate on the surface of the sea. It continued to accompany the boat for about fifteen minutes, when the sky cleared, and the beautiful object melted into air.

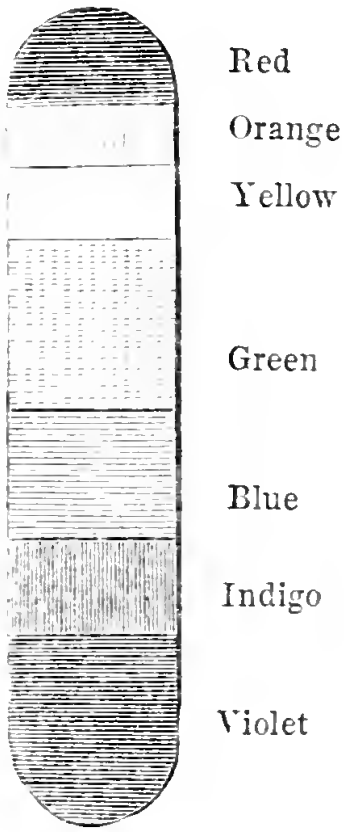
It is, however, a very remarkable fact, that, apart from the sun's rays, there is no such thing in nature as colour. All bodies, so far as this is concerned, are

therefore alike in the dark. A change in their appearance, however, may very easily be made. What seems more pure than the driven snow? yet if some of it be placed in a vessel by the fire-side, what becomes of its whiteness? A candle, however bright, placed under a cover, so that the smoke may be arrested in its ascent, leaves soot on the surface. Loaf-sugar melted over the fire, first turns brown, afterwards black, and a single grain of this colour will give a quart of pure water a yellow tinge.

The science of colour is full of wonders. Light is often considered as a simple substance; but this is far from being the case. The *white* light which comes from the sun, or any other luminous body, is generally considered as composed of *seven* different kinds of light, of different colours—*red*, *blue*, *yellow*, *green*, *orange*, *indigo*, and *violet*. To the experiments of Sir Isaac Newton we are much indebted. A statue of him, as engaged in them, appears in Trinity College, Cambridge.

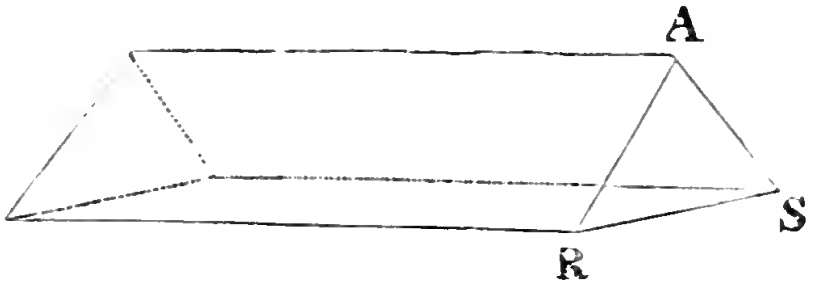
Having determined that a beam of white light, as emitted from the sun, consisted of seven colours, which possess different degrees of refrangibility, he measured the relative extent of the coloured spaces, and found them to have the proportions of the following figure. It presents a lengthened image of the sun, produced by

the rays being separated in different degrees from their original direction :—



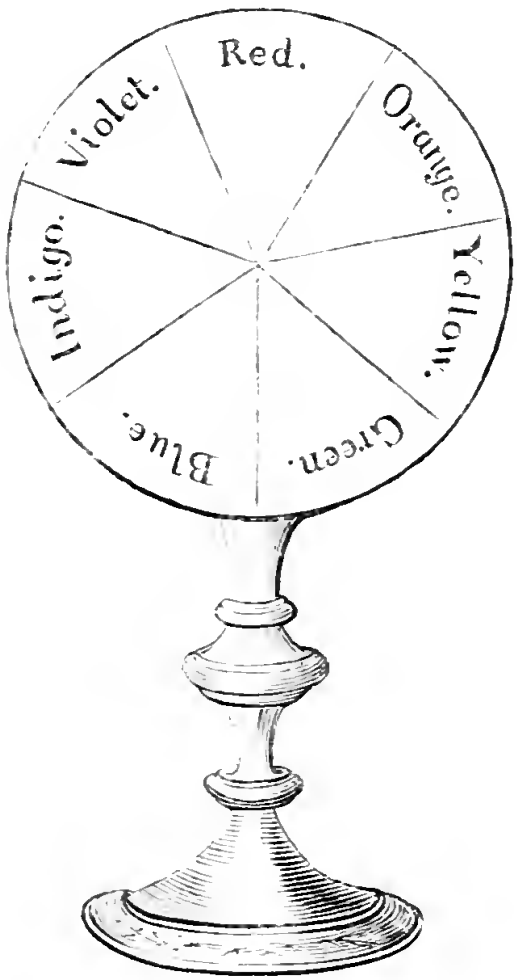
If we were required to decompose a *greenish grey* powder, consisting of fine brass and fine steel filings, we should do it by putting into the powder a loadstone, which would instantly attract all the blue steel filings, and leave behind the yellow brass filings, thus reducing the greenish grey powder into the yellow and blue dust of which it is formed. If, too, all the steel filings were much smaller than those of brass, a sieve, whose meshes would permit the steel to pass, while the brass was retained, would have separated them still more quickly.

To separate the colours of a ray of light, different means must be employed.



An optical prism, shown at A, is a solid glass, having two plane surfaces, A R, A S, which are called its refracting surfaces. The face R S is called the base of the prism. Now light may be as easily and speedily decomposed, by means of such a triangular piece of glass. To use it, the window-shutters should be closed, and a ray of light admitted through a small hole; as this falls on the prism, all the colours of the rainbow will be cast on the opposite wall, as in the previous figure, and with a brightness rarely equalled. An effect in some respects similar, yet of course inferior, is produced when the rays of the sun fall on lustres of cut glass. The prism, however, did not *form* these colours; they existed in the ray before its refraction by the glass; and when combined, they recomposed white light. This may be proved, rudely, though accurately enough for the purpose, by mixing together the seven colours in the following proportions:—red 45;

orange 27; yellow 40; green 60; blue 60; indigo 48; violet 80: or 360 in all. Or it may be seen still better, by painting the rim of a wheel with the seven colours, and making it turn very rapidly about its axis. In both cases the mixture of the colours will be a sort of greyish white; perfect accuracy, which, however, is not to be attained, would make it a pure white. The



coloured rays, separated by a prism, and made to fall on a glass which will bring them to a focus, causes

them to appear white. This effect may also be shown by an instrument which the cut represents. It is a disc, on equal divisions of which are painted the seven colours, and these being made to revolve on an axis with great rapidity, the disc appears almost colourless. Were a perfect arrangement made of the various hues, and also proportionate velocity given to the disc, no tint whatever would be discoverable.

In variety of colour, as well as in every other instance of Divine operation, we discover an end worthy the infinite Creator, who has made nothing in vain, and who doeth "all things well." And let us remember, that our duty and privilege are most graciously combined; for the inspired psalmist says, "The works of the Lord are great, sought out of all them that have pleasure therein.—He hath made his wonderful works to be remembered: the Lord is gracious and full of compassion," Psa. cxi. 2. 4. "Whoso is wise, and will observe these things, even they shall understand the loving-kindness of the Lord," Psa. cvii. 43.

CHAPTER VIII.

COLOURS OF BODIES—REMARKABLE ACCIDENT.

OTHER facts remain to be noticed, in reference to colour. If, for example, a piece of brown paper be held in the focus of a burning glass, it will take fire almost immediately, much sooner, indeed, than *white* paper, though that would appear more bright, because most of the rays, instead of entering into the paper, are reflected by it; whilst, on the contrary, the brown paper, which *absorbs more* light than it reflects, soon becomes heated and takes fire.

The reason of its doing so cannot be satisfactorily explained; but it is supposed that the particles of bodies are variously arranged, so that some reflect one coloured ray, and absorb the rest, whilst others reflect all the colours, and some absorb all.

A body always appears to be of the colour which it reflects; for, as we see only by *reflected* rays, it can only be of the colour they have. A violet reflects the

violet rays alone, and absorbs the others. Scarlet cloth absorbs almost all the colours, except red. Yellow cloth reflects the yellow rays most abundantly, and blue cloth those that are blue. Thus colour appears to be not a property of matter, but the result of matter acting on light. A white ribbon reflects all the rays, but when dyed red, the particles of the silk acquire the property of reflecting the red rays most abundantly, and of absorbing the others.

The dependence of colours on light may be shown in an interesting manner. Let a ray of light be admitted into a darkened room, and then refracted by a prism; if a rose be afterwards exposed to the red rays, the flower will appear more brilliant, but the leaves will be of a dingy brown, with a reddish glow, receiving this tinge from the reflection of a few of the red rays which blend with their natural blackness. If, afterwards, the rose be held in the blue rays, it will no longer be red, but of a dingy blue colour; while, as the leaves reflect both blue and yellow rays, which produce a green colour, and as they have a tendency to reflect the coloured ray in which they are placed, they will reflect more of the blue rays than the rose, and will appear of a brighter blue.

The colours of transparent bodies depend on the

property of unequal absorption; for they receive their colour from their power of stopping or absorbing some of the colours of white light and transmitting others. The rich dark light transmitted by a small blue glass is not one colour, like the blue or indigo exhibited by the prism, but a mixture of all the colours of white light which the glass has not absorbed. These are such as, mixed with the blue tint, would form white light.

When light is reflected from the surfaces of transparent bodies, or transmitted through portions of them with parallel surfaces, it is always white. The thinnest films of blown glass, or those of mica generally met with, will both reflect and transmit white light. If, however, their thickness be diminished to a certain degree, the light is in both cases coloured.

Could a film of mica be produced, with only one tenth part of the thickness of that which produces a bright blue colour, it would reflect no light, and would appear black, if viewed by reflection against a black body. Such a film is not likely to be made, yet accident, on one occasion, produced solid fibres as thin, and actually incapable of reflecting light. A crystal of quartz, of a smoky colour, being broken in two, the two surfaces of fracture were absolutely black, and this appeared at first to arise from a thin opaque film. But

this, it was found, could not be, and on examining the specimen with care, Sir D. Brewster found that the surface was perfectly transparent by transmitted light, and that the blackness of the surfaces was owing to their being entirely composed of a fine down of quartz, or of short and slender filaments, so exceedingly small as to be incapable of reflecting a single ray of the strongest light. Their diameter could not exceed the one-third of the millionth part of an inch.

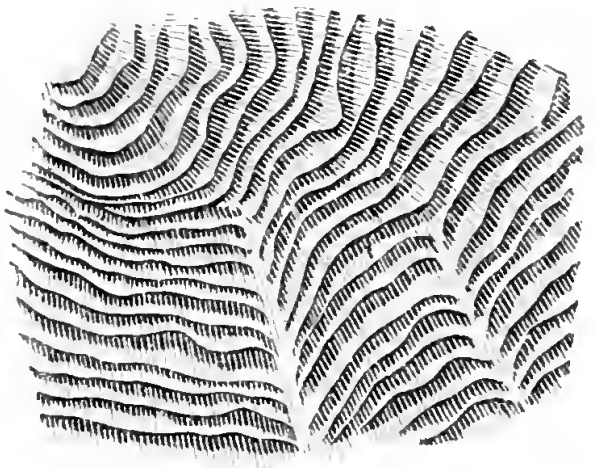
The colours of these plates, as they are called, may be easily seen. If a soap bubble be blown, and covered with a clear glass, to defend it from currents of air, a great many concentric coloured rings will appear round the top of it: after it has become thin by standing a little, the colour in the centre of the ring will vary with the thickness; but as the bubble gets thinner, the rings will expand, the central spot will become white, then bluish, and then black, after which the bubble will burst, from its extreme thinness at the place of the black spot. Sir Isaac Newton made certain calculations to show the thicknesses in millionth parts of an inch at which the colours are produced in plates of air, water, and glass. These enable us to measure minute thicknesses of transparent bodies by their colours, when all other methods would be inapplicable.

The colours of thick plates are also remarkable, as are those of fibres and grooved surfaces. When a candle is looked at through a plate of glass, covered with vapour or dust in a finely divided state, it is surrounded with a ring of colours like a halo round the sun or moon. These rings increase with the size of the particles producing them, and their brilliancy and number depend upon the uniform size of these particles.

Some curious results have arisen from this fact. By observing the colours produced by reflection from the fibres which compose the crystalline lenses of the eyes of fishes and other animals, Sir D. Brewster has been able to trace these fibres to their origin. The same mode of observation, and the measurement of the distance of the first coloured image from the white image, has enabled him to determine the diameters of the fibres, and to prove that they all taper like needles, so as to allow them to pack together as they converge to their points of origin.

The coloured images produced by these fibres, lie in a line perpendicular to the direction of the fibres. In several lenses he observed coloured images at a great distance from the common image; but he inferred from their direction that the fibres were crossed by joints or lines, whose distance was so small as the eleven thousandth part of an inch; and he lately found, by the

use of very powerful microscopes, that each fibre has in this case, teeth like those of a rack, of extreme minuteness, the colours being produced by the lines which form the sides of each tooth.



Of the same kind must be considered the principal colours of mother-of-pearl, a substance obtained from the shell of the pearl-oyster. These appear to arise from the peculiarity of its surface as above represented. On removing some of it, which had been fastened with a cement of resin and bees-wax, it was accidentally found that the mother-of-pearl really impressed on the cement its own power of producing the coloured spectra or images.

These colours, as given to a soft surface, are best seen by using black wax; but they have been transferred also to other substances, and even to clean surfaces of lead and tin by hard pressure, or the blow of a hammer. A

solution of isinglass or gum-arabic will take a most perfect impression from mother-of-pearl; and by placing the isinglass between two finely polished surfaces of mother-of-pearl, a film will be obtained, which, when seen by a single light, will shine with the brightest hues. This fact led to the idea of forming articles of steel, as buttons for gentlemen's dress, and articles of female ornament, covered with grooves, and beautifully arranged in patterns. To these were given the name of iris ornaments, properly taken from the rainbow. In daylight, the colours are not easily distinguished, unless occasionally; but in the light of the sun, and that of gas or candles, they are scarcely, if at all surpassed by the brilliant flashes of the diamond.

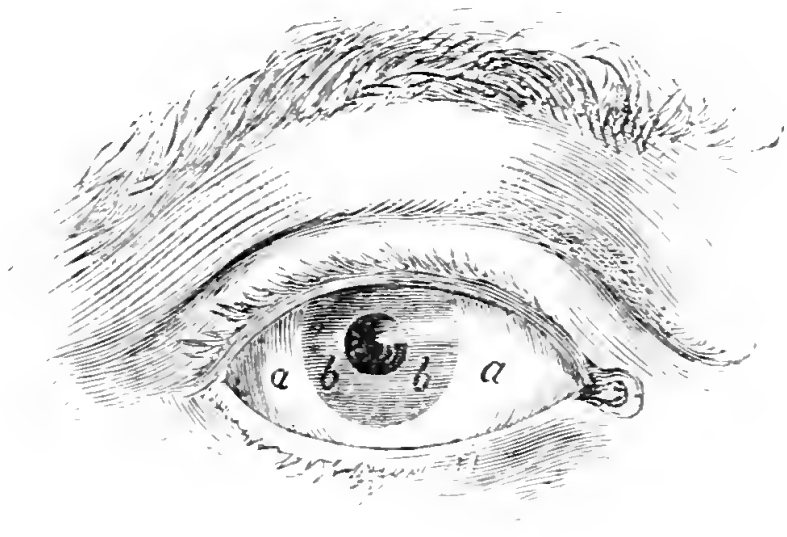
It is a curious fact, that some persons cannot distinguish the variety of colour, which others so easily perceive. The colour one individual was most at a loss with, was green, and in attempting to distinguish it from red, it was nearly guess-work. Scarlet he could tell in most cases, but he could not with any certainty tell a dark bottle-green from brown. Light yellow he knew; dark yellow he might confound with brown, though in most cases he thought he should know them from red. All the shades of light red, pink, and purple, he called light blue; but dark blue and black he

believed he could point out with certainty. Though he saw different shades in looking at a rainbow, it appeared as a mixture of yellow and blue—yellow in the centre, and blue towards the edges. Crimson curtains in the window of his bed-room seemed red in candle-light, and blue in day-light. The grass in full verdure appeared what other people called red, and the fruit of trees, when red, he could not distinguish from the leaves, except when he was near it, and then more from the difference of shape than of colour. A cucumber and a boiled lobster would be called by him the same colour, allowing for the variety of shade to be found in both ; and a leek in luxuriance of growth was to him more like a stick of red sealing-wax than any thing he could compare it with. A similar defect in vision had occurred in other instances in this individual's family. Happily, such exceptions to the ordinary power are exceedingly rare.

CHAPTER IX.

THE EYE—ITS AMAZING STRUCTURE—INSTRUCTIVE FABLE.

THE human eye is a most admirable piece of mechanism. It occupies a commanding situation, being placed in the upper part of the face, and, like a sentinel posted on a hill, it perceives at a glance every thing around. The purposes to which this exquisite instrument is adapted defy enumeration.

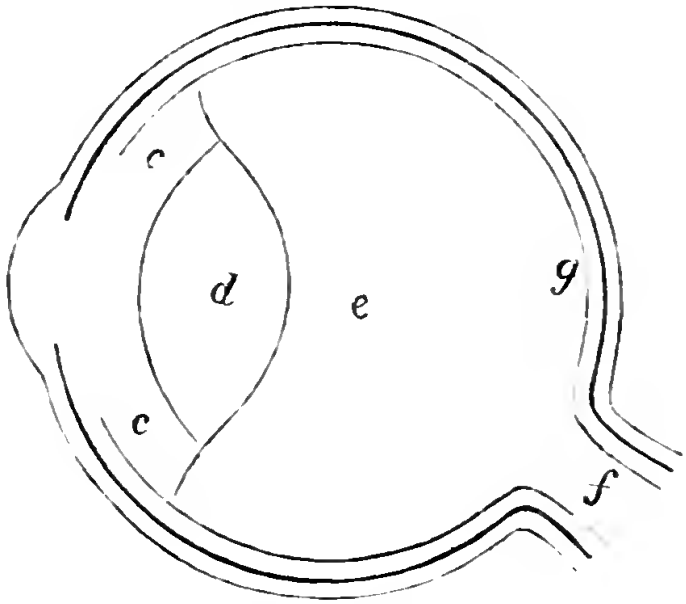


The eye is nearly spherical. Its first or outer coat is the white part, called sclerotica, marked on the figure

a a. It is every where opaque, except the small circular part in front called the cornea, *b b*, which is transparent, and fixed in the sclerotica like a glass in a watch-case; while to increase the power of vision, the anterior part of the eye projects and forms a large segment of a small circle.

The iris is the coloured circle which surrounds the pupil, varying in different persons, so that it is sometimes hazel, and in others black or grey. It is said to be the most acutely sensible part of the body, and is an opaque curtain in the inner chamber of the eye. The pupil in the centre of the iris may be so enlarged or contracted, as to admit a larger or smaller stream, according to the intensity of light. How admirable the provision that its diameter should be lessened when a very luminous object is presented to the eye; and that it should be increased in a faint light, in order that a greater number of rays may be admitted! The pain sometimes experienced when we suddenly come from darkness into a strong light, arises from the pupil being burdened by an undue quantity of rays before it has time to contract. In like manner, when we go from a strong light into obscurity, we at first imagine ourselves in total darkness, because sufficient rays cannot enter the contracted pupil to enable us to distinguish objects;

but, in a few minutes, the pupil dilates, and objects before invisible are clearly perceived.



Within the inner coverings of the eye are three humours. First appears the aqueous humour *c c*, of a watery consistence and perfectly fluid, that the iris may move in it with the utmost freedom. Immediately behind the pupil is the crystalline humour *d*; it collects the rays of light like a double convex lens, that they may thus be concentrated and a perfect image formed. At the back of this lens is the vitreous humour *e*, distending the ball of the eye into its spherical form, so that it may easily move in its orbit. Each of these humours has its distinct character, and according to their density they have different powers of refracting the rays of light, but all serving, in their united operation, to give the most correct image of the object, and in its truest colours.

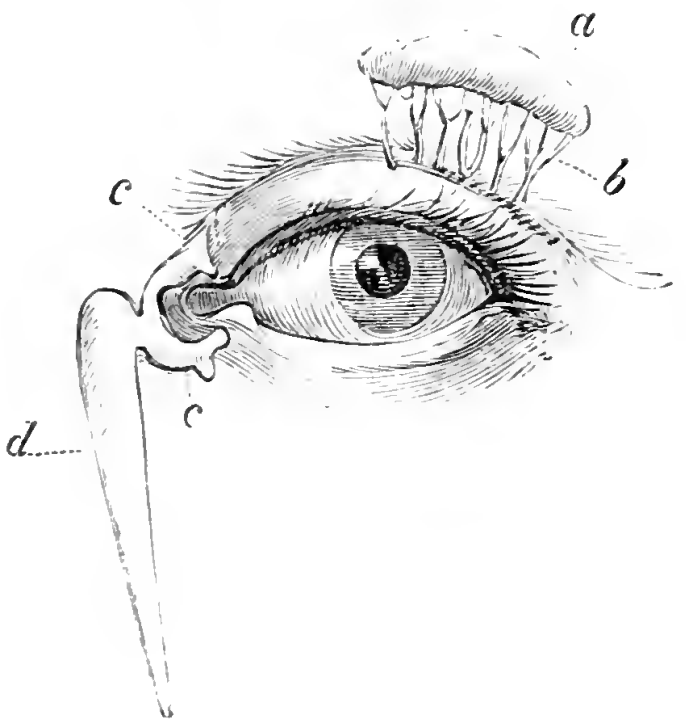
This appears exquisitely minute and distinct indeed, on the retina *f*, an expansion of the optic nerve *g*, and the immediate seat of sensation. It is a membrane of the most delicate texture of any in the human frame; according to Sir Charles Bell, it is transparent in a recent state, and so soft that it will tear with its own weight.

Most astonishing is the sensibility with which it is endowed, as proved by the great degree of light which the eye can bear, and the low degree of light at which objects are visible. Thus the proportion between the degrees of light illuminating it by the sun and by the moon, at any equal altitude, is calculated at 90,000 to 1. It has also been shown, that if we see the sail of a windmill six feet in diameter, at the distance of 4000 toises or fathoms, the eye being supposed to be an inch in diameter, the picture of this sail at the bottom of the eye will be one-eight thousandth part of an inch, which is the six hundred and sixty-sixth part of a line, or about the sixty-sixth part of a common hair!

Such, then, is a general description of the beautiful and admirable optical instrument which the great Artificer has placed in its socket, or orbit, formed of seven bones; and in which is deposited a loose fat, so that the eye may move as in a soft and warm bed. So

remarkably smooth is it, that though the eye performs thousands of movements every day, for seventy or eighty years, yet not the least injury is discoverable. But even this tender care is not enough. On the skin that covers these bones are hairs, which preserve the eye from dust and other inconveniences. As the cornea is constantly exposed to the action of the air, it is liable to become dry and parched, which would greatly injure its transparency, and consequently render the eye useless. Provision is therefore made for this necessity by the eyelids, which also afford a covering for defence, and for the exclusion of the rays of light. Other parts of this remarkable structure are no less admirable.

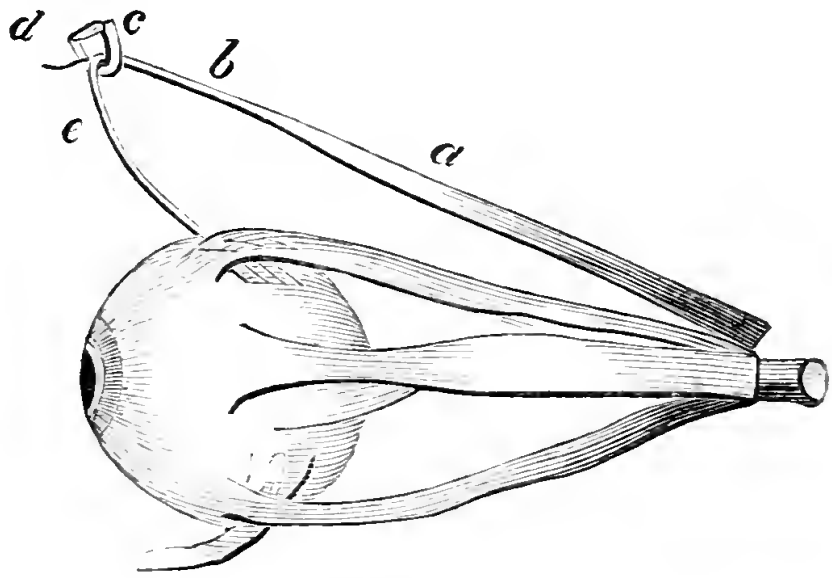
Thus the fore-part of the globe of the eye is connected with the surrounding integuments by a membrane, abundantly supplied with nerves, for the purpose of giving it that exquisite sensibility which is required to warn the eye of danger from the intrusion of foreign bodies. On arriving at the base of the eyelids, this membrane is folded forwards, so as to line their inner surfaces, and to be continuous with the skin that covers their outer sides. The surface of this membrane, called the conjunctiva, and also that of the cornea, are kept constantly moist by the tears, which are as constantly secreted by the lachrymal glands.



Each gland, as *a*, is situated above the eye, in a hollow of the orbit, and its several ducts, marked *b*, proceeding from it, open on the inner side of the upper eyelid. This fluid, the uses of which are obviously to wash away the dust, or any other irritating substance, is distributed over the outer surface of the eye by means of the eyelids; *c c* represent the puncta lachrymaliæ, which convey the tears into *d*, the lachrymal duct terminating in the nostril.

That we may be spared the trouble of turning the head towards the objects we wish to see, muscles are admirably contrived to move the eye in all directions. Passing over others which require a more particular description, one raises the orb of vision, another moves

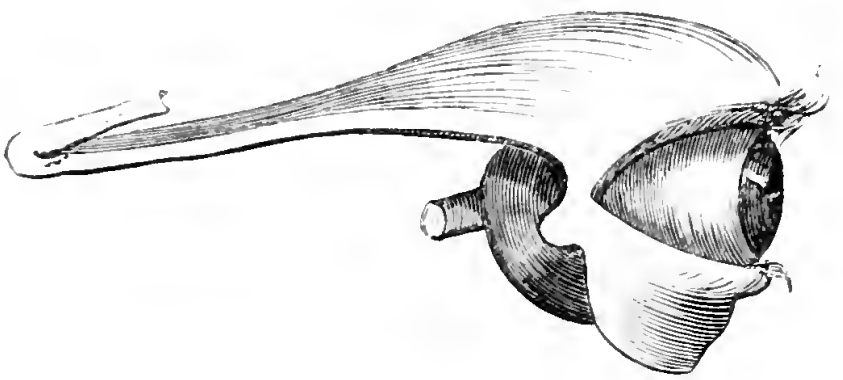
it outwards towards the temple, a third directs it towards the nose, and a fourth restrains within due bounds the action of the rest, and keeps it steadily fixed on the object it beholds.



One of these is very remarkable in its structure. It is the trochlear, or superior oblique muscle, which rises with the straight muscles; its muscular portion, *a*, is extended over the upper part of the eyeball, and gradually assumes the form of a smooth round tendon, *b*, which passes through the pulley *c*, fixed to the inner edge of the orbit *d*, then returning backwards and downwards *e*, is inserted into the sclerotic membrane.

It is from the protrusion of the eyeball that the upper eyelid is raised, and the lower eyelid depressed by one muscle. A depression of the inferior eyelid has been sought, but it is not found, such a muscle being

quite unnecessary. The *levator palpebræ superioris* opens wide the eyelids, depressing the lower eyelid at the same time that it elevates the upper one.



The above is a profile of this muscle in its natural position; it is inserted by a broad tendon into the upper eyelid. It will now be manifest that an apparently inconsiderable alteration would have been fatal to sight. "With much compassion, as well as astonishment at the goodness of our loving Creator," says an eminent writer, "have I considered the sad state of a certain gentleman, who, as to the rest, was in pretty good health, but only wanted the use of those two little muscles that serve to lift up the eyelids, and so had almost lost the use of his sight; being forced, as long as this defect lasted, to push up his eyelids with his own hands."

That the use of the eye may be understood, let a reading glass, which is a convex lens, be held at some

distance from a candle, with a piece of white paper placed behind it, at the distance of its focus, and the image of the candle will appear on the paper, in an inverted position—the focus being that point at which the image is seen most distinctly. A better effect may be produced by darkening a room, and placing the glass in a hole of a window-shutter, when the rays of light flowing from the objects without, and passing through the glass, will form, in the same manner, a picture of the objects opposite the window, on the white paper.

The writer is not likely to forget a circumstance which occurred in his boyhood. Having risen earlier one morning than the rest of the family, and gone into a room on the ground-floor, he was struck by a beautiful representation of part of the opposite house on a portion of one of the roller-blinds. He found on examination that a large knot had come out of one of the shutters, which remained closed; that the portion of the pane of glass opposite it acted as a lens, and that thus all within the range of the aperture was brought into view, and rendered, from the darkness of the room, exceedingly interesting.

In a similar manner are the images of objects painted on the back part of the inner coat or retina of the eye. This fact may be placed beyond all doubt;

for if the eye of an animal recently killed be taken, if the back part of the sclerotic coat be carefully removed, and if the eye, thus prepared, be placed between the spectator and the flame of a candle, so that the aperture of the pupil be turned towards it, a distinct inverted image of the flame will appear on the retina; and if two luminous objects be placed before the prepared eye, it will be seen, by removing one, that the image was painted on the side of the retina, the reverse of its real place. It appears, therefore, that the effect of the refractions that occur in the eye is to arrange the rays of light, when they reach the retina, into an exact but inverted picture of the objects from which they last proceeded. But in order to form such a picture, all, or the greater number of the rays which enter the pupil from single points of the object, must be assembled in focal points on the retina. When, from a want of exactness in the refractive power of the eye, the images on the retina are ill-defined, vision is indistinct.

Some other curious facts in connexion with vision may now be noticed. It is, for instance, not a little remarkable, that since an image must be formed on the retina of each of our eyes, we do not see objects double. But the action of the rays on the optic nerve is so exactly similar, that they produce only a single sensation;

the mind therefore receives the same idea from the retina of both eyes, and conceives therefore of only one object.

But while the vision thus accords with fact, and is strictly accurate, there are other cases when it is not so. Thus, if two coloured wafers be placed on a sheet of white paper, at the distance of three inches, and a person look at the left hand wafer with the right eye, at the distance of about eleven or twelve inches, taking care to keep the eye straight above the wafers, and the line which joins the eye parallel to the line which joins the wafers, and if then the left eye be closed, the right hand wafer will no longer be visible. The same effect will follow if the right eye be closed, and the right hand wafer be looked at with the left eye. The image of the invisible wafer has in each case fallen where the optic nerve enters the eye and expands itself to form the retina. But though a common light makes no impression on this part of the eye, a very strong one does, and even if candles be used, or highly luminous bodies instead of wafers, the body does not wholly disappear, but leaves behind a faint cloudy light, without, however, giving any thing like an image of the object from which the light proceeds.

If the objects are *white* wafers on a *black* ground, the white wafer absolutely disappears, and the space it

covers seems completely black. But here the perfection of the work of God is apparent. Though the base of the optic nerve is insensible to light that falls directly on it, yet it is susceptible of luminous impressions from the surrounding parts, and the consequence is, that when the wafer disappears, the spot it occupied has always the same colour as the ground on which the wafer is laid; it is white on a white ground, and red when it is placed on a red ground. Thus the insensible spot on the retina is stimulated by a borrowed light, and the apparent defect so completely removed, that its occurrence can only be determined by the experiment already described.

In addition to these facts, there is another truly astounding. It has been disclosed by modern optical discoveries, that every point of a medium through which a ray of light passes, is affected by successive periodical movements, recurring regularly at equal intervals, no less than five hundred millions of millions of times in a single second. It is by such movements, communicated to the nerves of our eyes, that, according to Sir John Herschel, we see.

We are also told by Dr. Young, that when we see the following colours, our eyes are affected in a second, or while we can pronounce one, as follows:—In *red*,

482 millions of millions of times; in *yellow*, 542 millions of millions of times; and in *violet*, 707 millions of millions of times.

In closing these general remarks on the eye, an ancient fable may be related, which is not without a good moral. Alexander the Great, it is said, traversing dreary deserts, came at last to a small rivulet whose waters glided peaceably along. Yet, tranquil and delightful as was this spot, it had no charms for him whose breast was swayed by ambition, and who cared not what sacrifices were made to gratify the passions of his soul. At length, overcome by hunger and fatigue, he was compelled to stop; when attracted by a river, on the banks of which he took his seat, he thought it must flow from some very rich and happy country, and determined to proceed thither.

Following the course of the river, he arrived, says the tale, at the gates of Paradise. Here he knocked, but in vain, for as he stated his character and rank, the answer was given, "None but the just can enter here." He now addressed an attendant spirit, saying, "Since you will not admit me, give me at least something, that I may show an astonished and admiring world that I have been where no mortal has ever been before me." "Here, madman," said the spirit, "here is something for thee.

It may cure the maladies of thy distempered soul. One glance at it may teach thee more wisdom than thou hast hitherto derived from all thy former instructors. Now go thy ways."

Alexander received the gift with avidity, and repaired to his tent; but what was his surprise and confusion to find that it was only the fragment of a human skull! Enraged and disappointed, he threw it on the ground. "Great king," said a learned man who happened to be present, "do not despise this gift. Despicable as it appears in thine eyes, it yet possesses some extraordinary qualities, of which thou mayest soon be convinced, if thou wilt order it to be weighed against gold or silver." Alexander directed it to be done. A pair of scales was brought. The skull was placed in one, and a quantity of gold in the other, when, to the astonishment of the beholders, the skull overbalanced the gold. More gold was added, still the skull was heavier. In short, the more gold there was put in the one scale, the lower sunk that which contained the skull.

"Strange!" exclaimed Alexander, "that so small a portion of matter should outweigh so large a mass of gold! Is there nothing that will counterpoise it?" "Yes," answered the philosophers, "a very little matter will do it." They then took some earth, and covered

the skull with it, when immediately the gold fell, and the opposite scale ascended. Much astonished at the result, Alexander inquired: "Can you explain this mystery?" "Great king," said the sages, "this fragment is the socket of a human eye, which, though small in compass, is yet unbounded in its desire. The more it has, the more it craves. Neither gold nor silver, nor any other earthly possession, can ever satisfy it. But when it is once laid in the grave, and covered with a little earth, there is an end to its lust and ambition."

CHAPTER X.

EFFECT OF EXPERIENCE—AUXILIARIES IN JUDGING OF OBJECTS—THE EYE THE MIRROR OF THE SOUL.

It appears that the first notions conveyed by our senses are very limited and imperfect, and that our real knowledge is acquired only after considerable observation and experience. The impressions of one sense are thus aided and corrected by others, and by the mind acting on the whole. The primary objects of vision seem to be simply light, or colour and expansion. Yet our judgments on vision are much more extensive, embracing also distance, magnitude, and what is called tangible figure, as that of a cube, or a sphere. The last is obviously the result of experience, derived from the sense of touch. Distance and magnitude, also, are not primary objects of vision; for persons who have suffered from blindness, and been restored to sight, have had no idea of either, but could only perceive expansion of surface with colour. Our judgment of these is therefore an acquired habit, founded on our knowledge of the

properties of objects received by other means. Accordingly, we have no idea of the distance of an object, unless we have some notion of its magnitude; nor of its magnitude, without some knowledge of its distance. In perspective drawing, the idea of distance is conveyed by the diminished size of known objects. On the same principle, known objects seen through a telescope do not appear to be magnified, but to be brought nearer.

An interesting proof of this occurred in the case of a boy who was blind from his birth, and who at the age of twelve, by the removal of what is called a cataract from his eyes, acquired the power of seeing. At first, he imagined that as what he felt touched his skin, so all the objects he saw did his eyes; nor could he distinguish one object from another, or judge of distances aright by the sight alone; the sense of touch was therefore called in to the aid of the power of vision. Being shown a small miniature of his father, and told what it was, he acknowledged a likeness, but was greatly surprised; asking how it could be that a large face could be exhibited in such little room, and remarking, that it would have seemed as impossible to him as to put a bushel into a pint. At first, he could bear only a little light, and the things he saw he considered extremely large; but on seeing things larger, those first seen he supposed less,

never being able to imagine any lines beyond the bounds he saw.

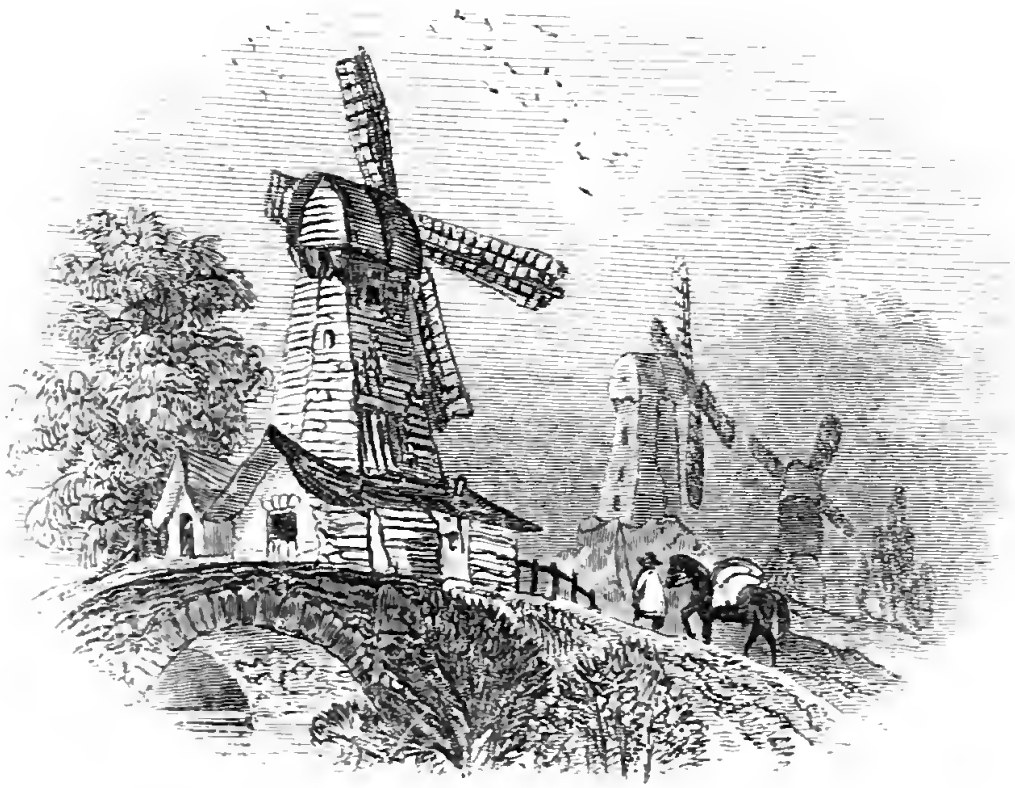
He said he knew the room he was in was but part of the house, yet he could not conceive that the whole house could look larger. Before he was couched, he expected little advantage from seeing, worth the endurance of an operation, except reading and writing; for he said he thought he could have no more pleasure in walking abroad than he had in the garden, which he could do very safely and readily. He observed, that even blindness had this advantage, that he could go any where in the dark much better than those who could see; and after he had seen, he did not soon lose this ability, nor did he desire a candle to go about the house in the night. He said that every new object was a new delight, and the pleasure was so great, that he wanted ways in which to express it; but he could not conceal his gratitude to Mr. Cheselden, the oculist, and for some time he never saw him without tears of joy, and other marks of affection. About a year after the operation, he was taken to Epsom Downs, and on the view of an extensive prospect, he was exceedingly delighted, and called it a new kind of seeing. The other eye being afterwards couched, he remarked, that objects at first appeared large to this eye, but not so large as they

did at first to the other; and looking on the same object with both eyes, he thought it appeared about twice as large as with the first couched eye only, but not double, that he could in any way discover.

The picture formed on the retina by the humours of the eye, causes, therefore, all the perceptions belonging to the sense of vision; yet the visible appearance which such pictures suggest, when taken by themselves, could have conveyed no notion of the size, distance, or situation of the object represented. It is consequently from the experience acquired by the use of other senses that we learn the connexion of these appearances with such objects, so that in the course of time the former become the signs of the latter. On the eye being directed, however, to any point of a landscape, it sees with perfect distinctness only that point of it which is directly in the axis of the eye, or the image of which falls on the central hole of the retina, but the other parts are discerned with sufficient distinctness for the enjoyment of its general effect. The apparent defect is supplied by the extreme mobility of the eye, and the duration of the impressions made on the retina; and thus the landscape is beheld as perfectly as if every part were seen with equal distinctness.

We are greatly influenced in our judgments by the

degree in which objects are illuminated, and that of the distinctness of their outline and minute parts. Thus in a picture, distant objects are pourtrayed as having a faint light, and, also, with indistinctness; while those which are near are represented as clearly defined, and in a strong light. In the same way, objects seen through a fog, or in obscure light, appear, as has already been intimated, much larger than they really are; because we first assume them to be distant, from their defective outline and faint light, and then, judging from this supposed distance, we conclude they are of great size.



On the other hand, objects seen when the atmosphere is unusually clear appear nearer than they actually are, from the greater distinctness of their outline.

In judging of distance, we are also greatly aided by the eye resting on intermediate objects. It is, therefore, difficult to do this at sea, and in other circumstances. Captain Parry found it so in reference to objects when viewed over an unvaried surface of snow. "It was not uncommon for us," he says, "to direct our steps towards what we considered a large mass of stone, at the distance of half a mile from us, but which we were able to take up in our hands after one minute's walk. This was more particularly the case when ascending the brow of a hill."

In our judgment, by vision, of the magnitude of objects, we are moreover much assisted by comparing them with others, the size of which is supposed to be known. "I remember once," says a modern writer, "having occasion to pass along Ludgate-hill, when the great door of St. Paul's was open, and several persons were standing in it. They appeared to be very little children; but on coming up to them, were found to be full grown persons. In the mental process which here took place, the door had been assumed as a known magnitude, and the other objects judged of by it. Had I attended to

the door being much larger than any door of ordinary size, the mind would have made allowance for the apparent size of the persons; and, on the other hand, had these been known to be full grown persons, a judgment would have been formed of the size of the door. On the same principle, travellers visiting the pyramids of Egypt have repeatedly remarked, how greatly the notion of their magnitude is increased, by a number of large animals, as camels, being assembled at their base."

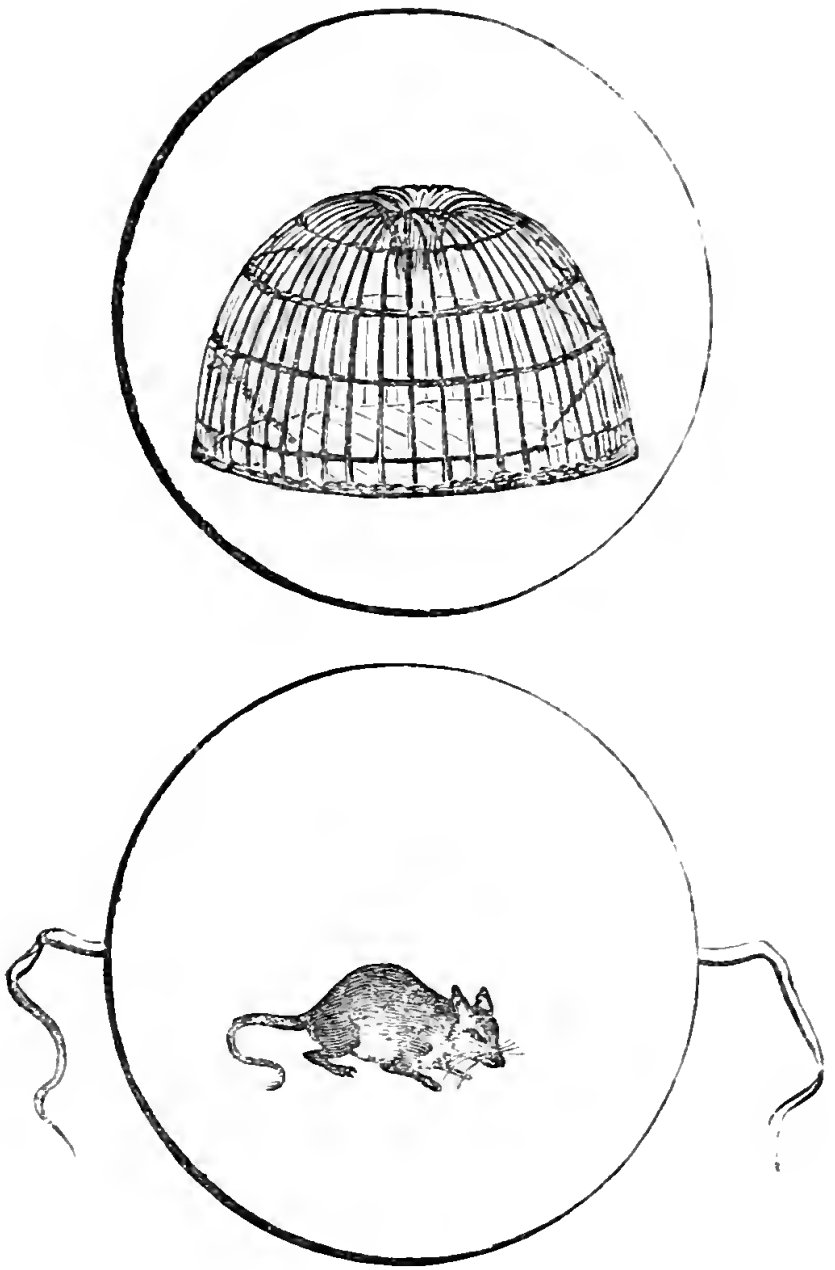
The judgments formed of the colours of bodies are greatly influenced by other coloured objects which are near, and modify the general sensibility of the retina. Any two colours which, being combined, produce white light, are said to be complementary to one another. Thus, when a small white or grey object is viewed on a coloured ground, it generally appears to assume a tint of the colour which is complementary to that of the ground itself.

The Chinese, in all their epistles of ceremony, employ paper of a bright scarlet hue, and Sir George Staunton told Dr. Roget, that for a long time after his arrival in China, the characters written on this kind of paper appeared to him to be green; and that he was afterwards much surprised at discovering that the ink employed was

a pure black, without any tinge of colour; and on closer examination he found that the marks were also black. In this case, the green appearance of the letters was an optical illusion, arising from the tendency of the retina, which had been strongly impressed with red light, to receive impressions corresponding to the complementary colour, which is green.

It is worthy of remark, that all impressions made on the nerves of sensation last for a short time after the cause producing them is withdrawn. Thus, if a piece of lighted charcoal be rapidly whirled round, it will give the idea of a circle of light, because the part of the retina which receives the bright image of the charcoal retains the impression with nearly the same strength during the whole revolution of light, when the same impression is renewed.

The thaumatrope, or wonder-turner, an amusing philosophical toy, is founded on the principle that an impression on the retina continues for about the sixth part of a second after the object which produced it is withdrawn. It is formed of a circular piece of card, about two inches and a half in diameter, which may be twirled round with great velocity by applying the fingers to pieces of silk string attached to two opposite points of its circumference, and having on each side some appropriate device. In the figure, the two sides of such a card are exhibited.



If, then, a card with these devices be set in motion by means of the strings, the two figures will be united, and the mouse will appear *in* the trap, in consequence of the impression of each continuing on the retina for a short space of time after its removal. Other devices

are easily exhibited: as a garden pot, which is filled with a rose-tree; a leafless branch, which is covered with verdure; and a horse, which is provided with a rider. Parts of a sentence may also be written on one side, and the rest of it on the other; and the halves of letters or words may be also disposed in the same way. A solid axis of rotation, it may be observed, is better than strings, and will produce much more pleasing combinations.

It is not a little singular, that impressions of visible objects remaining for some time after the eye is shut, or has been withdrawn from them, are generally accompanied by some remarkable change in the colour of the objects. One case mentioned by Dr. Darwin is as follows:—"I covered a paper about four inches square with yellow, and with a pen filled with a blue colour, wrote upon the middle of it the word BANKS in capitals; and sitting with my back to the sun, fixed my eyes for a minute exactly on the centre of the letter N in the word. After shutting my eyes, and shading them somewhat with my hand, the word was distinctly seen in the spectrum, in yellow colours on a blue ground; and then, on opening my eyes on a yellowish wall at twenty feet distance, the magnified name of BANKS appeared on the wall written in golden characters."

Dr. Abercrombie also gives a similar instance. A friend of his had one day been looking intensely at a small print of the Virgin and Child, and had sat down, bending over it for some time. On raising his head, he was startled by perceiving at the farther end of the room a female figure of the size of life, with a child in her arms. The first feeling of surprise having subsided, he instantly traced the source of the illusion, and remarked that the figure corresponded exactly with that which he had contemplated in the print, being what painters call a kit-cat figure, in which the lower parts of the body are not represented. The illusion continued to be distinct for about two minutes.

Disease, and generally fever, produces, frequently, false impressions. A lady, in a slight disorder of this kind, saw distinctly a party of ladies and gentlemen sitting round her bed-chamber, and a servant handing something to them on a tray. The scene continued for several days, in a greater or less degree; and was varied by spectacles of castles and churches of a very brilliant appearance, as if they had been built of finely-cut crystal. There was no degree of insanity in this case; the effect was owing entirely to fever, and the patient amused herself and her attendants by watching and describing the changes that took place.

Singular effects may also be frequently noticed in health. It often happened to Sir William Herschel, when, in a fine winter's night, and in the absence of the moon, he was occupied several hours in taking sweeps of the heavens with his telescope, that by shutting out the light of surrounding objects from the eye by means of a black hood, the sensibility of the retina was so much increased, that when a star of the third magnitude approached the field of view, he found it needful immediately to withdraw his eye, in order to preserve its powers. On one occasion, Sirius appeared like the dawn of the morning, gradually increasing in brightness, till it attained all the splendour of the rising sun, compelling him quickly to retreat from the beautiful but overwhelming spectacle.

But without adding to these interesting facts in reference to vision, the view that may often be enjoyed is truly amazing, while there are some objects which cannot but fill the mind with admiration. Let us take, for instance, an Italian prospect. "It was," says a traveller, "on the morning of our leaving Turin I had a better view of the magnificent scenery with which it is surrounded. Starting at six, we soon arrived at the bridge of the Po, and I looked, of course, for the mountains; for in the horizon, opposed to the coming sun, I perceived

a faint red, which served to mark their outline. While the rest of the world was still buried in night, they had caught the beams of day. By-and-bye, their colour varied into a rich roseate hue, which contrasted beautifully with the violet tint of the mist that lay in darkness at their feet. As morning advanced, a red hot glow succeeded; and the vast amphitheatre of Piedmont was in its whole western section lighted up with an ineffable and overwhelming radiance. In the eastern horizon, the golden hues of an Italian sky formed a magnificent back-ground, against which were relieved the towers of the Superga, and the picturesque outline of the neighbouring hills. Soon their aspect was again changed; the mist had fallen like a curtain at their feet, and the precarious tints of dawn had ripened into a twilight grey. The mountains themselves, in their whole vast extent, now seemed a wall of fire—iron in the furnace could not have glowed with an intenser red, than did those stupendous masses in the rays of morning; never did I witness a scene of such overwhelming magnificence—a wall of fire as extensive as half the circumference; its battlements, pyramids, and towers, shooting upwards into heaven, while the bases of the mountains were clothed in vapour, and the valley was pervaded with the grey mist of twilight. Against

this brilliant back-ground, the distant town, the majestic river, and the rich eastern sky, composed a landscape, which brought the tears into my eyes, and closed my lips in silent delight."

In such circumstances, the multitude of rays of light, falling from the various objects of which so sublime a scene is composed, must be immense. How many must issue, for instance, from unnumbered parts of the Superga, to render them visible; to say nothing of the multitudes that must pass through the surrounding atmosphere! Millions, multiplied by millions, must go forth every instant from that edifice! Yet even these must be far inferior to those which issue from the various objects of so extended a landscape. The mind is confounded as it glances at them, all passing forward in perfect order, no one interfering with another, but each one producing its appropriate effect. Still further, the rays, instead of all being directed to the spot the traveller occupies, are diffused around, so that the same effect would be produced were there thousands, instead of one solitary spectator. From a defective vision alone, would the beauty and sublimity of the whole scene be marred, in the instance of any individual. Nor is this all, for in every case this part of Italy would be depicted in distinctness, accuracy, and beauty, on the

retina, in a space of which the diameter is not half an inch! Here, assuredly, is the finger of God!

"Marvellous," O Lord, "are thy works; and that my soul knoweth right well," Psa. cxxxix. 14. After all, the eye is only an unconscious instrument in the hands of the Supreme. "In him we live, and move, and have our being," Acts xvii. 28. In the power of vision, and in a thousand other ways, does the Divine Being operate. He is in us and around us, directing every movement in our animal frame. Well, then, may the question arise, "Canst thou by searching find out God? canst thou find out the Almighty unto perfection?" Job xi. 7.

If, however, the objects presented to the eye are frequently most interesting and amazing; and if the representations of them on the little mirror within are truly wonderful, it is no less certain that the outward aspect of the organ of sight is exceedingly intelligent and expressive. The looks of the individual often discover the condition and frame of the mind. Here may be seen the various passions of the human soul, and they have often even a kind of silent and yet significant language, conveying to others the inward exercises which the tongue does not, and perhaps cannot express. We perfectly understand a look of surprise, of fear, of

sorrow, or of affection, and so it is in a great diversity of instances.

We could not, therefore, doubt the meaning, were we passing a house on fire, if we saw some fellow-creature at a window or on a parapet, casting on us his wild and eager eyes; but we should at once understand his language to be that of earnest importunity for prompt and speedy help. Equally intelligible, therefore, is the Divine command, "Look unto me, and be ye saved," Isa. xlv. 22. It manifestly requires those exercises of mind which are expressed by the earnest and significant looks of persons in a state of distress towards a deliverer. It means, assuredly, a fixing of the attention on the Lord Jesus Christ, as the Almighty and compassionate Saviour—a longing for the deliverance he only can effect—an earnest appeal for his aid—an entire reliance on Him who alone can afford it—a supreme love to Him, and fervent gratitude for his great and inestimable blessings.

Here, then, is the great duty of "all the ends of the earth;" of sinners and of saints, of men in every place and in every age. To the one class the charge comes, that they may turn away their eyes from the vanities of the world, and fix them on the Redeemer, as the Israelites wounded by the fiery flying serpents looked to the

BRAZEN SERPENT.

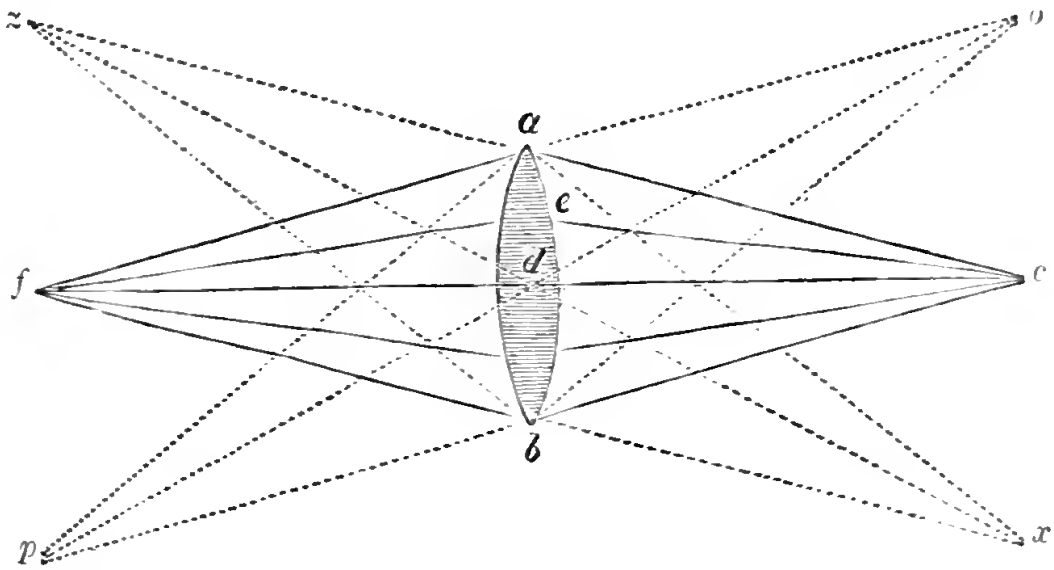
serpent of brass elevated in the midst of the camp,—and looking, lived. It addresses the other, that, beholding as with open face in a glass the glory of the Lord, they may be changed into the same image from glory to glory, as by the Spirit of the Lord, 2 Cor. iii. 18. May this be the privilege of every one who reads these pages!

CHAPTER XI.

LENSES—THE TELESCOPE—THE MICROSCOPE—VARIOUS OPTICAL INSTRUMENTS.

To introduce the interesting facts which remain to be stated, it must be premised, that the five rays of light in the following figure—the representatives indeed of innumerable rays—issuing from the point *c*, are said to form a pencil of light. It is also evident that to make all such rays converge or meet again in one place, as *f*, beyond a transparent body placed at *a b*, it would be necessary, while the middle ray *c d* remained straight, for the others to be bent more and more, in proportion to their distance from the centre *d*. According, then, to the law of refraction, that light entering from air through the surface of any denser medium, is bent there towards the perpendicular,—if a piece of glass were placed at *a b*, of such a form that the rays falling on it from *c* should meet and leave its surfaces with greater and greater obliquity, in proportion as the points of

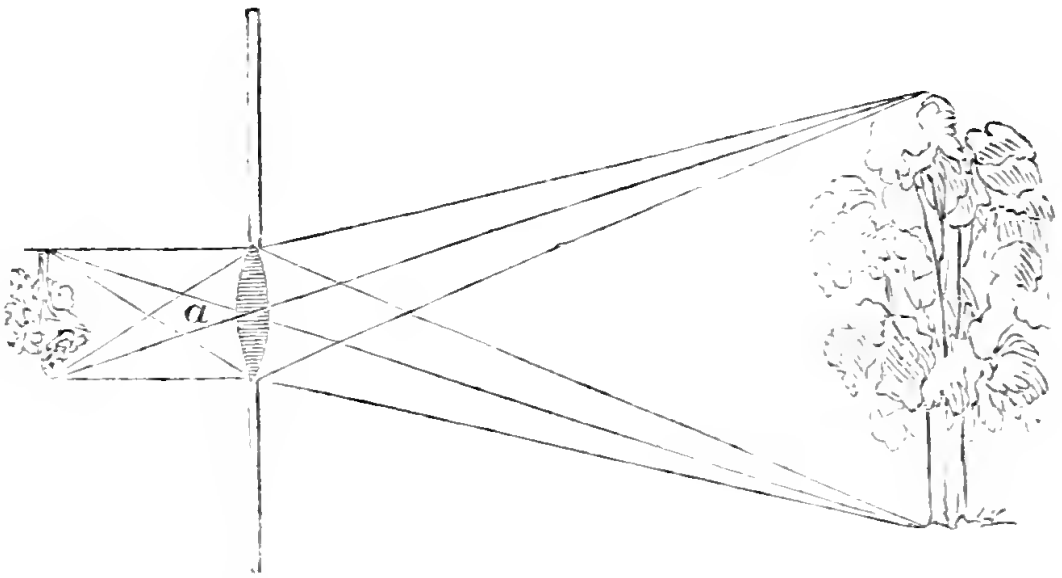
incidence are more distant from the centre, the purpose would be gained.



Now a glass having a regular convexity will answer this purpose; it is therefore represented, with its effect, in the figure; the ray in the centre going straight through to *f*, and the others being bent in proportion to their distance from the centre. The point *f* is generally called the focus, of which an explanation has already been given. The focus, it should be observed, is always in the direction of the central ray of the pencil of light: if the light issue from *o*, it will be at *p*; and if it come from *x*, it will be at *z*.

This property of a lens, to bring together all the rays of light which traverse it from any one part of an object placed before it, renders it of great value. If,

for instance, one be placed at *a*, occupying an opening in the window-shutter of a darkened room, then from any object before it, as the tree which is represented, all the light which each point of the tree sends forth towards the lens will be concentrated in a focal point behind it; and if a sheet of paper be held there, it will have upon it a beautiful image of the object.

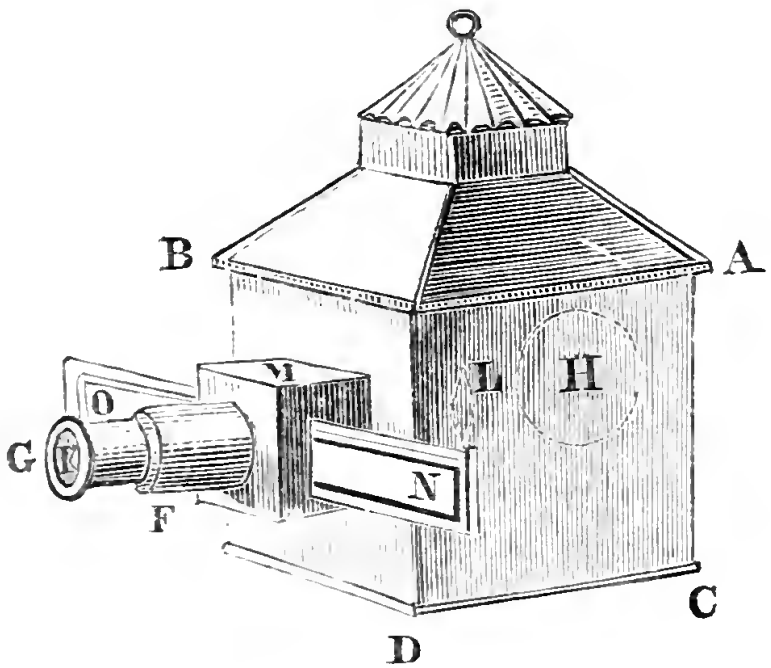


This is the way in which the interesting machine acts called the camera obscura, or dark chamber. Some large ones may be seen at public exhibitions, the effect of which is very striking; others of a small size, like the one which now appears in use, are also calculated to yield much gratification.

To this the structure of the magic lantern bears a strong resemblance. It may be described as follows.

CAMERA OBSCURA.

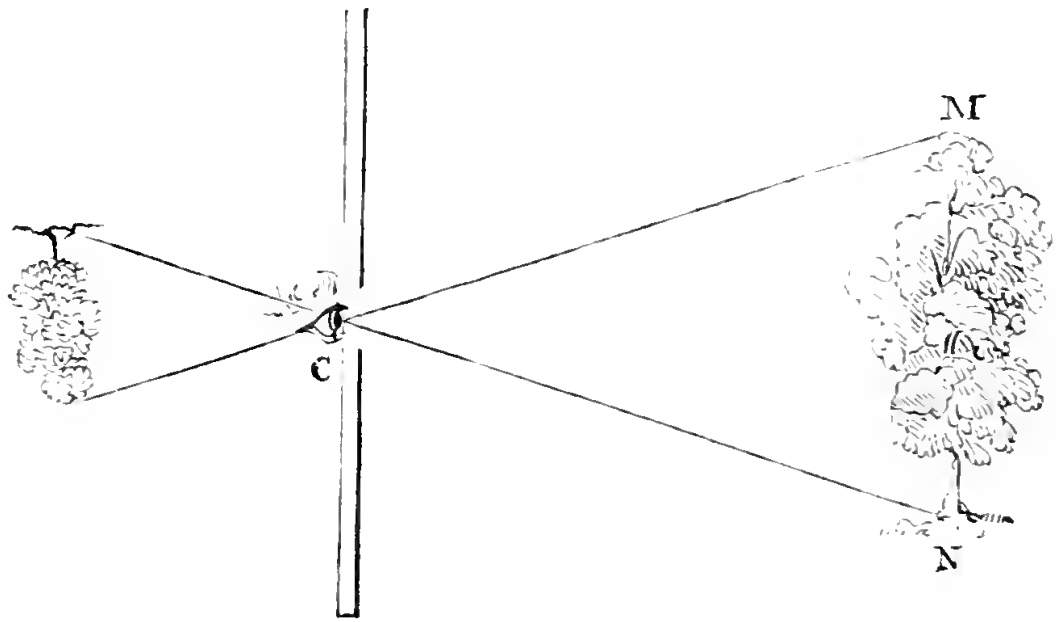
A B C D represent the lantern, having a draw-out tube F G. In H is fixed a metallic concave speculum, in the focus of which is placed a lamp L, and within the tube is a spherical lens. The extreme part of the tube F M is square, and has an aperture quite through it, so as to receive the frame N O, holding a glass, and any others of the same size. On each slide, as it is called, figures are painted at pleasure with transparent colours. These images, fitted into the frame, and placed invertedly at a little distance from the focus of a lens at K, will be thrown on the opposite white



wall, or a sheet, of a darkened room, greatly magnified in all their colours, and in an erect position.

In using a lens, the object to which it is directed

appears to increase in size, and also to be brought nearer the spectator. Now, to understand this, it must be observed, that all objects are seen under a certain angle. Take, for instance, the following tree, with the direction of the rays expressed by lines: the ray which comes from the top M, and that which proceeds from the foot of the tree N, meet at the pupil C, forming an



angle of about 25 degrees; this, then, M C N, is called the angle of vision, under which the tree M N is beheld.

If, then, a sovereign were placed at a distance of 100 yards, the angle would be very small, and the object itself hardly visible. If, now, the distance be reduced to about a fourth of what it was, the apparent magnitude of the coin will be increased, and it will appear to be circular; while, as it is made to approach

us, the head of the monarch and the inscription gradually acquire distinctness, and this small piece of money actually conceals a mansion or castle in the distance. The coin has, in fact, been magnified by its being brought nearer the eye, and all its parts have become, in consequence, distinctly visible.

Again, let a sovereign be placed at the distance of twenty feet, and a convex lens, whose focal length is five feet, be placed ten feet from the coin, and ten also from the eye, that is, just half way between the two, and the image of the sovereign will not be directly magnified; but if the image be brought so near that it can be seen at the distance of six inches, its apparent magnitude will be increased forty times.

When the eye is placed behind the lens, and sees the image in the air, the apparatus is a telescope, from two Greek words, signifying, *to see at a distance*, though this name is commonly given only when there are two or more lenses. It is said that the invention of this instrument was owing to a spectacle-maker's boy having accidentally taken up two convex glasses of different focal distances, and placing the one near his eye, and the other at a considerable distance, he perceived, on looking through them, the spire of a neighbouring church turned upside down, and much larger than its usual size.

Amazed at this singular appearance, the father of the boy adjusted two glasses on a board, supporting them in two brass or wooden circles, which might be removed to, or farther from, each other, at pleasure. Such appears to have been the origin of a most valuable invention.

Galileo, a distinguished philosopher, when on a visit to Venice, heard that a Dutchman of the name of Jansen had constructed, and presented to Prince Maurice, an instrument through which he saw distant objects magnified, and rendered as distinct as if they had been brought near to the observer. The idea instantly filled his mind as one of great importance to science, and so thoroughly was he acquainted with the properties of lenses, that he not only discovered the principle of its construction, but completed a telescope for his own use. Into one end of a leaden tube he fitted a spectacle glass, plane on the one side and convex on the other, and at the opposite end he placed another spectacle glass, concave on the one side and plane on the other. He then applied his eye to the concave glass, and saw objects "pretty large, and pretty near him." Soon after, he made another instrument, which represented objects about sixty times larger; and, sparing neither labour nor expense, he finally constructed so

good a one as "to show things almost a thousand times larger, and above thirty times nearer to the naked eye." It is not to be supposed, however, that his telescope had what opticians call a power of 1000 times.

Father Zucchius appears to have been the first person who magnified objects by means of a lens and a concave speculum. The first who described a reflecting telescope with a small speculum, was James Gregory, of Aberdeen. He was led to its invention by the inconvenience in employing spherical lenses, and the great difficulty of so freeing them from the prismatic colours, that objects might be observed distinctly and closely. He determined, therefore, to construct a telescope, in which metallic specula, or highly polished mirrors, should be used instead of lenses. This contrivance was peculiarly happy, not only as obviating the chief objection to refracting telescopes, but as leading to the invention of the reflecting telescope by Sir Isaac Newton.

That distinguished philosopher made one, six inches long, which magnified about forty times—a greater number than any six feet refracting telescope could do with distinctness. He considered this little instrument as in itself contemptible, yet he regarded it as "an epitome of what might be done." With fresh zeal he applied him-

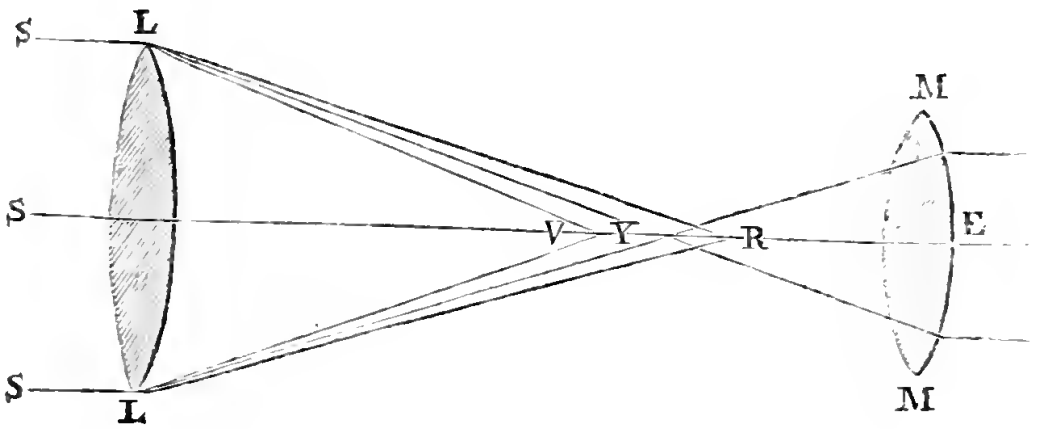
self, variously and fully engaged as he was, to the laborious work of making another. This, which was better than the first, excited some interest at Cambridge, was shown to the king and some of the most eminent philosophers of the time, and is carefully preserved in the library of the Royal Society of London. It bears the following inscription: "Invented by Sir Isaac Newton, and made with his own hands, 1671."

The labours of the late Sir William Herschel ought not to be forgotten. With an ardour never before exhibited, he constructed two hundred seven-feet Newtonian reflectors. Under the munificent patronage of George III., he also made a telescope forty feet long, and on the 27th of August, 1789, the day on which it was completed, he discovered with it the sixth satellite of Saturn.

Herschel was able to apply a power of 6450 to the fixed stars; but a very much lower one was generally used. In this telescope, the observer sat at the mouth of the tube, and looked with his back to the object. In order to prevent the head and other parts of the body from obstructing too much of the light, the image was formed out of the axis of the speculum. As the frame of the instrument was exposed to the weather, it became at length greatly decayed. It was therefore taken down, and another erected in 1822, by the present Sir J.

Herschel, with which he has made many valuable discoveries.

The course of the makers of telescopes was, however, beset by great difficulties. A sunbeam received on a screen, after passing through a small round hole in a window-shutter, appears like a round white spot; but when a prism is interposed, the beam no longer occupies the same space. It is separated, as we have seen, into the prismatic colours, and while its *breadth* remains the same as the spot, it is spread over a line of considerable *length*. The act of spreading is called the *dispersion* of the coloured rays. But these, in passing through transparent substances, are differently *bent*, so that the lights of different colours come to a point at *different* distances, and thus form an indistinct image. This was long found to make telescopes imperfect, and hence it became



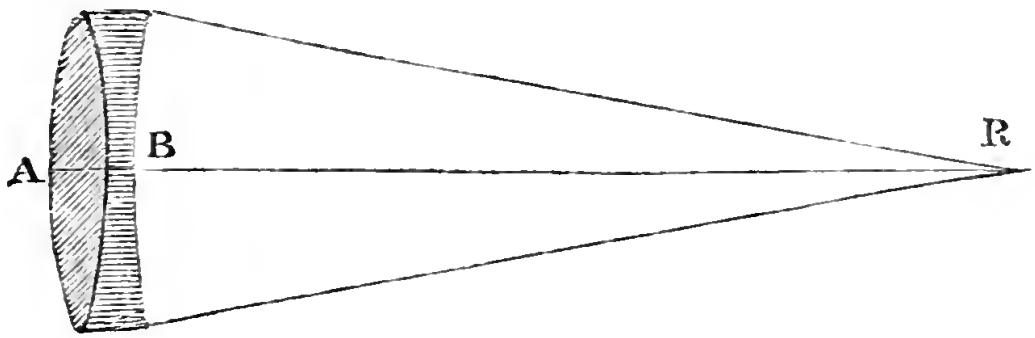
L

necessary to make them of reflectors or mirrors, and not of magnifying glasses; the same difference not being observed to affect their reflection.

The difficulty that existed may be illustrated by the preceding figure. L L is a convex lens, and S L, S L rays of the sun falling on it in parallel directions. Now the violet rays existing in the white light being more refrangible than the rest, will be the more bent, and will meet at V, forming there a violet image of the sun. Just so the yellow rays will form an image of the sun at Y; while the red being the least refrangible will be brought to a focus at R, and there form a red image of the sun. If, therefore, L L be the object glass of a telescope directed to the sun, and M M an eye-glass, through which the eye at E sees the image or picture of the sun formed by L L, it cannot see distinctly the different images between R and V. If adjusted to one, it will not see distinctly any of the others; there will therefore appear one distinct image, with indistinct images of the rest; producing, consequently, great confusion of vision.

A desire to remove this difficulty led to a variety of experiments, and, as the result, it was found that different substances have very different dispersive powers. Thus the images formed by two equal prisms, yet of different

substances, though the circumstances under which they are used are equal, are of *different lengths*. A prism of *flint* glass, and another of *crown* glass, will clearly show this difference, and the use of the two together obviated the difficulty so long experienced.



The achromatic telescope consists of a tube with a lens at one end, to bring the rays to a focus, and form an image of the distant object, and at the other end a magnifying glass with which to view the image thus formed. Before, it was found that the object glass, instead of making the rays converge to one point, dispersed them, and gave a confused and coloured image; but, by constructing it of two lenses A B, in contact, as in the figure, one of flint, and the other of crown glass, the dispersion is counteracted, and a well-defined and colourless image of the object is formed at R.

Such an effect was thought impossible till Mr. Hall, a gentleman of Worcester, constructed a telescope in this

manner, in 1733. When, however, John Dollond, the son of French parents, whom the revocation of the edict of Nantes compelled to find an asylum in England, began his labours, he was doubtless entirely ignorant of the efforts of Mr. Hall, and may be said to have re-invented the instrument just mentioned. "I have," he says, "after numerous trials, and resolute perseverance, brought the matter at last to such an issue, that I can construct refracting telescopes with such apertures and magnifying powers, under limited lengths, as, in the opinion of the best and undeniable judges who have experienced them, far exceed anything that has been produced, as representing objects with great distinctness, and in their true colours." This, which must be pronounced the finest and most important improvement made in optics, since the great discovery of the unequal refraction of the several rays of light, was the result of a long series of trials, directed with great judgment and ingenuity, but very little aided by the powers of calculation. Such a procedure was probably the best suited, however, to the habits of the artist, and it had, at least, the advantage of leaving behind it no doubt or hesitation.

Many improvements have been made of late in these instruments, by a person named Guinand, who was born

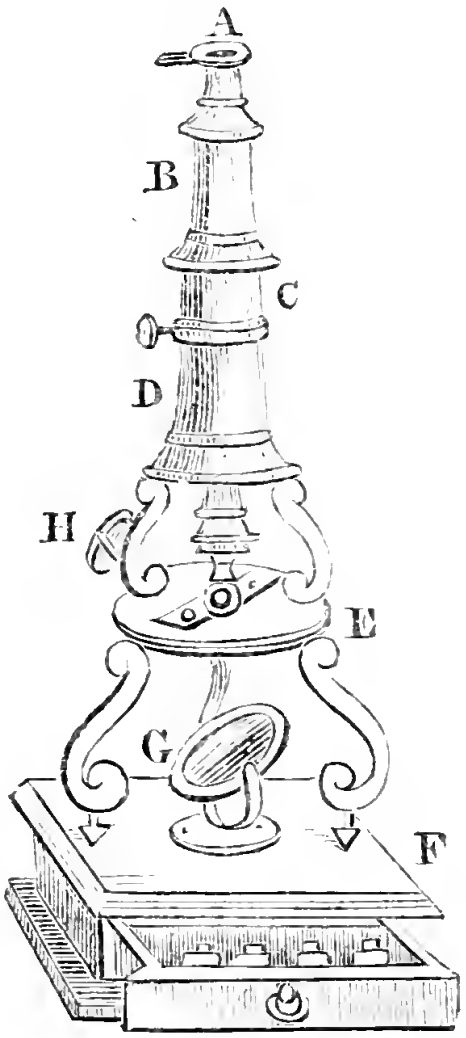
in an inconsiderable village, among the mountains of Neufchatel, in Switzerland. His father was by trade a joiner, and his son received, therefore, but little instruction; indeed, he always read with difficulty, and wrote very imperfectly. When between thirteen and fourteen years old, he quitted the employment of a joiner for that of a cabinet-maker, chiefly engaged in making cases for clocks, and obtained some knowledge of the art of casting and working in metals, of which he afterwards availed himself, by becoming, when twenty years of age, a watch-case maker; the manufacture of watches forming a very considerable branch of industry in that part of the country.

His movements afterwards were very interesting. At the house of a person for whom he then worked, young Guinand had an opportunity of seeing, for the first time, a very fine reflecting telescope, which had been made in England, and which at once appeared to him so curious and interesting, that he requested and obtained leave to take it in pieces, the more minutely to examine its construction. The use of this was soon apparent in the construction of a similar telescope; and the one which he made with his own hands was pronounced by many competent persons to be equal in excellence to that which had served for a pattern.

He subsequently applied himself particularly to ascertain the proper composition of flint glass; and having spent twenty or thirty years in making experiments, he at length succeeded in obtaining glass for an achromatic telescope, of larger dimensions and of superior quality to what could formerly be procured. Of this glass was formed the largest triple achromatic telescope ever constructed; it was lately erected in the observatory of the university at Dorpat, under the direction of M. Fraunhofer. This glass is perfectly free from veins, and has a greater power than any obtained before. M. Guinand produced several telescopes of great magnitude, and remarkable for their excellence. "These," says a memoir of him, "have been constructed by an old man upwards of seventy, who himself manufactures the flint and crown glass which he uses in their construction, after having made with his own hands the vitrifying furnace and his crucibles; who, without any mathematical knowledge, devised a method of ascertaining the proportions of the convexity that must be given to the lenses; afterwards works and polishes them by means peculiar to himself; and lastly, constructs all the parts of the different mountings, either with joints or on stands; melts and turns the plates, solders the tubes, prepares the wood, and compounds the varnish."

The microscope is also a very remarkable instrument. The *single* microscope consists simply of a convex lens, commonly called a magnifying glass; in the focus of which the object is placed, and through which it is viewed: by this means we are able to bring the eye very near the object, and thus the latter is magnified by the lens. The lenses which have the shortest focus will magnify the object most, because they enable us to bring the object nearest to the eye. The point, too, to which any magnifier collects the light, is more or less distant as the magnifier is smaller or rounder; so that a small globe of glass, or any transparent substance, makes a microscope. The *double* microscope is more complex, and has proportionate power.

The following is a representation of an elegant and powerful instrument of this kind, as set out for use. A is the slide head to receive the eye; B the eye-tube, containing two powerful lenses; C the slide-tube, by which the instrument is adjusted; it moves smoothly on a spring through the body, D; E is a circular brass table, in the middle of which is an apparatus for receiving ivory sliders, containing the objects to be viewed; G is a mirror adapted to reflect light upon them; H is an auxiliary for the same purpose; and F is a box to contain the magnifiers and other articles.



The solar microscope was invented by Mr. Lieburkuhn, in 1738 or 1739, and is composed of a tube, a looking-glass, a convex lens, and a Wilson's microscope. The rays of the sun being reflected through the tube by the mirror on the object, its image is thrown distinctly and beautifully on a screen, or white linen sheet, placed at a proper distance. The object may be magnified to a great extent by the removal of the screen ; the farther

it is distant, the larger the object will appear, so that an insect may be magnified to the length of several feet.

As the light of the sun is so uncertain in this climate, and the solar microscope can only be used in the finest part of the day, it has long been wished to find one by which objects might be viewed under any circumstances. This light has at length been obtained. Two gases, hydrogen and oxygen, are mixed, ignited, and thrown on a piece of lime; thus a light is produced of extraordinary brilliancy, the rays of which are collected by means of lenses, and concentrated on the objects. It is affirmed that they are magnified by this means, from ten thousand to two million times.

The various objects presented to the eye by means of the hydro-oxygen microscope may well awaken interesting and profitable emotions. Among these are transverse sections of wood—the elytra, or wing cases of insects—the wings themselves, with the dust which comes off at the touch of a finger, appearing in regular order as scales—the feathers of birds, of a structure equally exquisite—the eyes of flies, with their thousands of hexagonal convex lenses—the hair of the head magnified to the thickness of the human arm—the flea, far surpassing in size the elephant—and a single drop of water, in which are distinctly seen multitudes of creatures in full activity,

and some of a formidable appearance. Nor should the process of crystallization be overlooked. Salt of any kind being dissolved in water, a drop is put on a piece of glass, and this being placed in the microscope, the shootings of the salt as the water evaporates assume a great variety of beautiful forms.

In the use of an instrument of inferior power, a writer thus describes the objects he beheld:—"The principal flower in this elegant bouquet was a carnation, the fragrance of which led me to enjoy it frequently and near. The sense of smelling was not the only one affected on these occasions: while that was satisfied with the powerful sweet, the ear was constantly attacked by an extremely soft but agreeable murmuring sound. It was easy to know that some animal within the cover must be the musician, and that the little noise must come from some little body suited to produce it. I instantly distended the lower part of the flower, and, placing it in a full light, could discover troops of little insects frisking and capering with wild jollity among the narrow pedestals that supported its leaves, and the little threads that occupied its centre. What a fragrant world for their habitation! What a perfect security against all annoyance in the deep husk that surrounded their scene of action! I was not cruel enough to pull

out any of them for examination; but adapting a microscope to take in, at one view, the whole base of the flower, I gave myself an opportunity of contemplating what they were about, and this for many days together, without giving them the least disturbance. Thus could I discover their economy, their habits, and their enjoyments. The base of the flower extended itself under the leaves, and became trunks of so many stately cedars; the threads in the middle seemed columns of massy structure, supporting at the top their several ornaments; and the narrow spaces between were enlarged into walks, parterres, and terraces. On the polished bottom of these, brighter than Parian marble, walked alone, or in large companies, the winged inhabitants; these, from little dusky flies, (for such only the naked eye would have shown them,) were raised to glorious, glittering animals, stained with lively purple, and with a glossy gold that would have made all the labours of the loom contemptible in comparison. I could at leisure, as they walked together, admire their elegant limbs, their velvet shoulders, and their silken wings; their backs vying with the empyrean in its blue; and their eyes, each formed of a thousand others, out-glittering the little planes on a brilliant—above description, and too great almost for admiration."

Among the curious experiments recently made with the microscope, are many by Dr. Ure, on the structure of the fibres of flax and cotton. The filaments of the former he describes as having a glossy lustre when viewed by daylight, and a round, or cylindrical form, which is very rarely flattened. Their diameter is about the two-thousandth part of an inch; and they break with a smooth surface like a tube of glass cut with a file. On the contrary, it is said, the filaments of cotton are scarcely ever cylinders, but are more or less flattened, so that when seen under the microscope, they appear in one part like a riband from the one-thousandth to the twelve-hundredth part of an inch broad, and in another like a sharp edge or narrow line. They have some degree of transparency in the middle space, with a dark narrow border at each side, like a hem. When broken across, the fracture is fibrous or pointed. During a recent visit of Dr. Ure to Manchester, he showed to several skilful spinners the power of his microscope to distinguish the different qualities of cotton wool, and satisfied them that such an instrument would prove a valuable guide in the purchase of cotton.

He also mentions an instance of the importance of such researches in the ordinary business of life. Cassava and arrow-root are nearly similar in appearance,

use, and properties; but they differ in their origin, their place of production, and also in their import duty; cassava being from foreign colonies, and therefore liable to a rate of twenty shillings per hundred weight, while arrow-root being from our own colonies, is admitted at the rate of one shilling per hundred weight. Some time ago Dr. Ure was called on to give an opinion on an article entered under the name of arrow-root, which was suspected to be cassava. He placed a little of it under the microscope, and proved to a commissioner and surveyor-general of the Customs that it was cassava, because it consisted of minute spherical particles in clusters, while arrow-root consists of particles very different in form, and nearly double the size.

Who, a few centuries ago, could have thought of such results as these? A powerful microscope makes the finest muslin appear like coarse sacking; and the exquisitely polished needle like a rugged, uneven surface, with a blunted point. Yet brought to this test, the works of God appear in their perfection; the sting of the bee, however magnified, retains all its polish and acuteness. Other wonders also meet the view. The little body of the May-bug, only an inch in length, has recently been shown to have 306 hard pieces, serving as envelopes, 494 muscles, 24 pairs of nerves, and 48 pairs

of trachea. Numberless creatures, moreover, though so minute that a million of them are less than a grain of sand, are made, by this means, objects of vision. Such an instrument gives us, as it were, a new sense. The eminent and devout philosopher, Mr. Boyle, remarked, that "his wonder was greater at Nature's watches than its clocks," and here they are opened to our view, and demand our admiration.

The telescope and the microscope have been finely compared by Dr. Chalmers:—"The one," he says, "leads me to see a system in every star—the other leads me to see a world in every atom. The one taught me that this mighty globe, with the whole burden of its people and its countries, is but a grain of sand on the high field of immensity; the other teaches me that every grain of sand may harbour within it the tribes and the families of a busy population. The one told me of the insignificance of the world I tread upon; the other redeems it from all its insignificance; for it tells me that in the leaves of every forest, in the flowers of every garden, and in the waters of every rivulet, there are worlds teeming with life, and numberless as are the glories of the firmament. The one has suggested to me, that, beyond and above all that is visible to man, there may be fields of creation, which sweep immeasurably along, and carry

the impress of the Almighty's hand to the remotest shores of the universe; the other suggests to me that, within, and beneath all that minuteness which the aided eye of man has been able to explore, there may be a region of invisibles; and that, could we draw aside the mysterious curtain that hides it from our senses, we might see a theatre of as many wonders as astronomy has unfolded! an universe within the compass of a point, so small as to elude all the power of the microscope; but where the wonder-working God can raise another mechanism of worlds, and fill and animate them all with the evidence of his glory."

CHAPTER XII.

VALUE OF ARTIFICIAL LIGHT — ANCIENT LAMPS — IMPROVEMENTS OF M. ARGAND — PERILS OF MINERS — DREADFUL EXPLOSIONS — THE SAFETY LAMP OF SIR H. DAVY — GASEOUS EXHALATIONS IN INDIA, PERSIA, AND AMERICA — HISTORY OF LIGHTING BY GAS — ITS APPLICATION TO DOMESTIC PURPOSES.

If we except the essential articles of food and shelter, it may be safely said, that nothing is more necessary to the comfort of man than artificial light. Accordingly, it has been sought, to a greater or less extent, by all people.

We read much of the bronze lamps used by the Egyptians, the Greeks, the Romans, and other nations of antiquity; many of which are to be seen in private collections and public museums. Though some were of elegant construction, the principle was in all equally simple: the wick was inserted by means of a small tube, or merely through a convenient opening, in a

vessel containing oil. As they generally cast a large shadow, the body of the lamp was sometimes made, to prevent this inconvenience, with a projecting beak or spout, something like a cream ewer, so that by placing the wick in this part, the light in one direction was comparatively but little impeded. Much smoke must, however, have been produced.

Without such aid, a considerable portion of time in the climates inhabited by civilized men must be wasted in idleness; and though the privation might not be felt by the listless dwellers in the torrid zone, to us who live in the region of unequal nights and days, the want of it would operate as a check on improvement, and present a great barrier to the provision of the necessaries of life. It is no wonder that in this country, where such is the fact, and where the arts have made so much progress, considerable attention should have been given to the manufacture and improvement of lamps. Many of these articles have discovered great ingenuity.

Until a recent period, however, the principle of the burner was the same; but to afford a sufficient supply of air was attended by considerable difficulty. Though a small wick produced only a small flame, yet the light was brilliant, because it was so fully in contact with the air; while when the wick was larger, though the flame

was also increased, yet for want of air to the inner part the light was dull, and much of the oil, without being inflamed at all, passed off in smoke.

To increase the flame, and yet to render it bright, a number of little wicks were placed side by side in a line; but this plan was troublesome, and did not answer the expectations that were raised. It was therefore a happy thought of M. Argand, of Geneva, about half a century since, that if the wicks could be arranged in a circle, and the air admitted through the interior of it, the brightness of a large flame might be secured. But this was not to be accomplished at once: a lamp was made in this way, but the light was not proportionate, and the quantity of smoke produced by efforts to increase it would have proved fatal but for the following circumstance. While Argand was continuing his experiments, his younger brother observed a broken-off neck of a flask lying on the chimney-piece, and placing it over the flame of the lamp, it immediately rose very brightly. Great was their mutual joy: the Argand lamp was now complete; for though various alterations have been made in other respects, the burner remains just what it was, and the glass chimney is still necessary.

Another important invention is connected with many

affecting circumstances. Miners are exposed to peculiar dangers. "At one time," says Dr. Walsh, "an odour of the most fragrant kind is diffused through the mine, resembling the scent of the sweetest flowers, and while the miner is inhaling the balmy gale, he is suddenly struck down and expires in the midst of his fancied enjoyment: at another, it comes in the form of a globe of air, enclosed in a filmy case; and while he is gazing on the light and beautiful object floating along, and is tempted to take it in his hand, it suddenly explodes, and destroys him and his companions in an instant."

The resemblance thus presented to sin is obvious. It addresses the senses and promises gratification, but it attracts only to deceive, and deceives only to destroy. "Look not thou," says Solomon, "upon the wine when it is red, when it giveth his colour in the cup, when it moveth itself aright. At the last it biteth like a serpent, and stingeth like an adder." A similar charge may be given, and a similar declaration may be made in reference to every forbidden gratification. The promise, however flattering, is sure to be broken; but the misery attendant on sin will certainly come. The way of transgressors is hard. "Their vine is of the vine of Sodom, and of

the fields of Gomorrah : their grapes are grapes of gall, their clusters are bitter : their wine is the poison of dragons, and the cruel venom of asps," Deut. xxxii. 32, 33.

In suffering merely, transgression does not terminate. "When lust hath conceived, it bringeth forth sin: and sin, when it is finished, bringeth forth death." This is "the wages of sin." Apart from its commission, the eyes would not have become dim, nor the hand have lost its cunning, nor the heart have ceased to beat, nor the body have been laid in the grave. Sin has made the world a vast sepulchre. Yet this is not all: there is another death; for "the *soul* that sinneth, it shall die." What that inspired declaration means, no tongue can fully tell, no mind can adequately conceive. It is the endurance of eternal wrath—the wrath of God,—the wrath of the Lamb!

How great, then, is the folly,—the madness of transgression! It dares this wrath for ever for the trifling and empty,—yea, for the often distracting pleasures of iniquity. And frequently it comes: ages of insufferable pain are the consequences of these moments of sin: they afford no real joy, they are speedily gone, and then the transgressor "lies down in sorrow."

The ravages of these evils which come so insidiously on the miner—evils, like sin in their aspect and their

COAL MINE.

issue—have often been very fearful. The mere enumeration of the instances in which men have been scorched, stifled, or suddenly hurried into eternity, singly, or by scores, would occupy a large space. In 1812, an explosion took place in the Felling Colliery, and as soon as it was heard, the wives and children of the colliers ran to the working pit. Wildness and terror were pictured in every countenance. A crowd soon collected from all sides, to the number of several hundreds, some crying out for a husband, others for a parent or a son, and all deeply affected with anxiety, grief, and horror. Thirty-two persons, all that survived this dreadful calamity, were brought to daylight, and along with them the dead bodies of two boys, three other boys dying in a few hours. Only twenty-nine persons were therefore left to relate what they had observed; one hundred and twenty-one were in the mine when the explosion happened, and eighty-seven remained in the workings. On June 18, 1835, an explosion of gas also took place in the works of what is called "the Church Pit," in the Wallsend colliery, by which one hundred and one human beings—about three-fourths of them boys—were suddenly hurried into the eternal world.

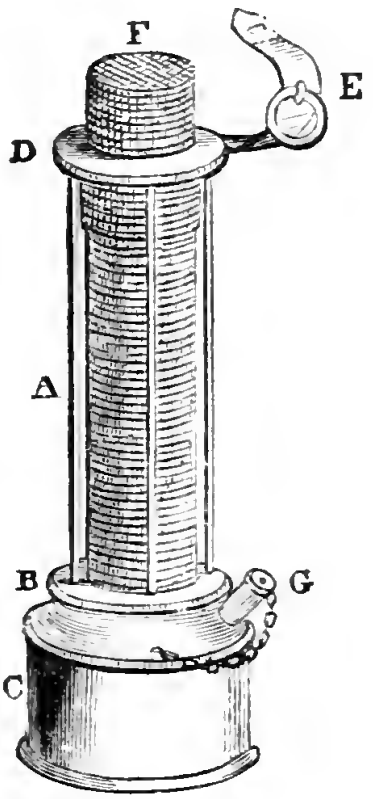
In consequence of the former calamity, the mind of the late Sir Humphrey Davy was led to consider if any

thing could be done to prevent its recurrence. After many researches, he saw that to light mines in which there was fire-damp with perfect security, it was only necessary to use a well-closed lantern, supplied with air from small tubes, through which explosions cannot pass, and with a chimney at the upper part, on a similar plan, to carry off the foul air. Such was the first "safety lamp" he produced.

This was afterwards improved, and it was perfectly safe in the most explosive atmosphere; but this put out the light: a wire-gauze cage was therefore afterwards adopted, and in this the fire-damp itself continues to burn, and thus to give the miner a useful light, while he is secured from or forewarned of the effects of explosion. All that is required for his guidance and protection in the darkness of the mine is, that the candles or lamps in use be surrounded by small wire cages; these being perfectly safe, at once supply air to the flame, and light to the miner.

The annexed cut represents the lamp at present in use. A is a cylinder of wire-gauze, with a double-top, securely fastened by doubling over to the brass rim B, which screws on the lamp-vessel C. The whole is strengthened and protected by strong supports of iron wire, rivetted into a piece at D. The lantern is carried

or suspended by the ring attached to the flap at E, which allows of being turned aside on its hinge, that the gauze cap, F, which is slipped on to guard against the top being burnt through, may be easily taken off every night, and examined by the miners. G is the tube where oil is supplied.



This grant to the miner by the ingenuity of man may well suggest another to ourselves in the tender mercy of God. To the human race, doomed to death as the consequence of sin, and exposed also to that which is eternal, revelation is an infallible safety lamp. No one has gone astray who has made it a guide. The path

in which it directs the feet is the path to heaven. What a contrast, too, is this to the way of the wicked! Wisdom's "ways are ways of pleasantness, and all her paths are peace," Prov. iii. 17. Yea, "the path of the just is as the shining light, that shineth more and more unto the perfect day," Prov. iv. 18. How precious, then, is this heavenly gift! Well may we adopt the language of the poet:—

"Word of the ever-living God!
Will of the glorious Son!
Without thee how could earth be trod,
Or heaven itself be won?

Yet, to unfold thy hidden worth,
Thy mysteries to reveal,
The Spirit that first gave thee forth
Thy volume must unseal.

And we, if we would rightly learn
The wisdom it imparts,
Must to its heavenly teaching turn
With simple, child-like hearts."

Among modern improvements, there is yet one which must be noticed, connected, as it is, with artificial light, —it is that of lighting by gas. Gaseous exhalations, it should be observed, are common in different parts of the world, as in India and Persia. There are some of these natural gas-vents in China, which have been

burning for centuries, and are turned to economical account. Beds of coal, though at a great depth, are frequently pierced by the borers for soft water, and from the wells thus made, the inflammable vapour springs up; it sometimes appears as a jet of fire, from twenty to thirty feet high, and in the neighbourhood of Thsec-Lieon-Teing, the salt works were formerly heated and lighted by means of these fountains of fire. Bamboo pipes carry the gas from the spring to the place where it is intended to be consumed. These tubes are terminated by tubes of pipe-clay, to prevent their being burnt. A single well heats more than 300 kettles. The fire thus obtained is said to be so exceedingly brisk, that the cauldrons are rendered useless in a few months. Other bamboos conduct the gas intended for lighting the streets, and the great rooms or kitchens. Thus nature presents in this place a complete establishment of gas light. As the whole of the gas cannot be employed, the excess is conducted beyond the limits of the salt-works, and there forms three chimneys or columns of flame.

Springs of water, charged with inflammable gas, are also common in the south-western part of the state of New York. In one case, a ravine is formed of clay-slate, and a small brook runs through it. The gas rises through fissures of the slate from both the margin and

bed of the brook. Where it ascends through the water it is formed into bubbles, and flashes only when flame is applied; but where it rises directly from the rock, it burns with a steady and beautiful flame, which continues until extinguished by storms or design.

Other springs, more recently discovered in a field which had long been cleared, are very numerous. Their places are known by little hillocks, a few feet in diameter, and a few inches high, formed of a dark mould, which seems principally to have been deposited by the gas, and through which it finds its way to the surface in one or more currents. These currents of gas may be set on fire, and will burn with a steady flame. In winter they form openings through the snow, and being set on fire, exhibit the novel and interesting effect of a steady and lively flame in contact with nothing but snow. In very cold weather, it is said, tubes of ice are formed round these currents of gas—probably from the freezing of the water contained in it, which sometimes rises to the height of two or three feet,—the gas issuing from the tops; the whole, when lighted on a still evening, presenting an appearance even more beautiful than the former.

The manufacture of gas on a large scale, and with a

commercial object, long preceded the idea of applying the vapour so abundantly produced of late for the purpose of illumination. In a work published at Frankfort, in 1683, by John Becher, he says, "In Holland there is turf, and in England there are coals, neither of which are good for burning, either in apartments or smelting-houses. I have, however, discovered a method of burning both these to good coals, so that they shall not only produce no smoke or bad smell, but yield as strong a heat for melting metals as that of wood, *and throw out such flames, that a foot of coal shall throw out a flame ten feet long!*" Here we have not only the idea, but an actual description of the phenomenon produced by a common gas apparatus. The author proceeds:—"This I have demonstrated at the Hague with turf, and proved here in England with coals, in the presence of Mr. Boyle, by experiments made at Windsor on a large scale. It deserves to be remarked on this occasion, that as the Swedes procure their tar from fir wood, I have procured tar from coals, which is in everything equal to the Swedish, and even superior to it for some purposes. I have tried it both on timber and ropes, and it has been found excellent. The king himself (Charles II.) ordered a proof of it to be made in his presence. This is a thing

of great importance to the English; and the coals, after the tar has been extracted from them, are better for use than before."

The burning of gas in a well at Wigan, in Lancashire, long since extinguished, led to various experiments by Dr. Clayton. He not only distilled the gas, which he called the spirit of coal, but he filled bladders with it, and frequently amused his friends by burning it like a candle. The application of this inflammability to any useful purpose seems, however, not to have occurred to any person; and this is one of the many examples of even philosophical and observing men disregarding the useful and important discoveries almost thrown in their way.

For many ages the attractive property of amber, when rubbed, was known before the electric fluid was brought into more intense action. The magnifying power of globes of glass was seen by philosophers of Rome eighteen centuries ago, but no one dreamed of telescopes or microscopes. In like manner seal engraving, and the art of impressing letters and figures on wax and clay, were in practice twenty centuries before Laurentinus Coster first thought of raising the art of impression as a means of multiplying the art of writing.

In 1798, however, gas was applied to useful purposes. Mr. Murdoch constructed an apparatus at the Soho

Foundry, in Birmingham, which was used during many nights for the lighting of the building; and, in 1802, an illumination of the manufactory, in honour of the Peace, afforded an opportunity of publicly displaying the result. The spectacle presented was as beautiful as new, and the numerous population gazed with delight at such an extraordinary display of taste and brilliancy. About two years after, the general nature of gas-light illumination was exhibited by a German, named Winsor, in London: but the apparatus by means of which he obtained the coal-gas, and the mode of purification which he adopted, were kept secret. In 1807, Pall Mall was thus lighted, and it continued for some years to be the only street in London so illuminated. After this, a Company was formed, and in the course of three or four years they began to realize the profitable effects of their exertions; the utility of gas was becoming daily more obvious, and the current of public opinion was turned rapidly in its favour. Applications were now made for private lights from various parts of the metropolis, and in many streets the oil lamps were quite discarded. Its subsequent success is familiar to all.

A singular application of gas has more recently been made. Some years ago the proprietor of a field in America, containing burning springs, put into operation a plan for

applying the gas to purposes of economy. From a pit which was sunk in one of the hillocks, the gas is conducted through bored logs to the kitchen of the dwelling, and rises through an aperture, a little more than half an inch in diameter, in the door of a cooking stove. When inflamed, the mixture of gas and common air in the stove first explodes, and then the stream burns steadily. Even this small supply is said to be sufficient for cooking.

Efforts were recently made to apply gas to the same purpose in this country. Some friends of the writer's attended a public lecture in one of our large manufacturing towns, on the importance of its adoption. A large cooking apparatus supplied with gas was exhibited, by which a great variety of dishes was prepared, of which the persons attending the lecture were requested to partake at its close, that they might have the fullest proof that every one was literally "well done."

CHAPTER XIII.

THE PRIVATION OF LIGHT A PROOF OF THE DIVINE CARE—ITS EFFECT ON INFERIOR CREATURES—THE SLUMBER OF VEGETABLES—CURIOUS RESULTS OF PLANTS GROWING IN THE DARK—THE RESPIRATION OF PLANTS—INTERESTING SPECTACLES OF EVENING AND NIGHT—THE DAY SHOULD CLOSE AS WELL AS BEGIN WITH PRAYER—IN HEAVEN THERE SHALL BE NO NIGHT.

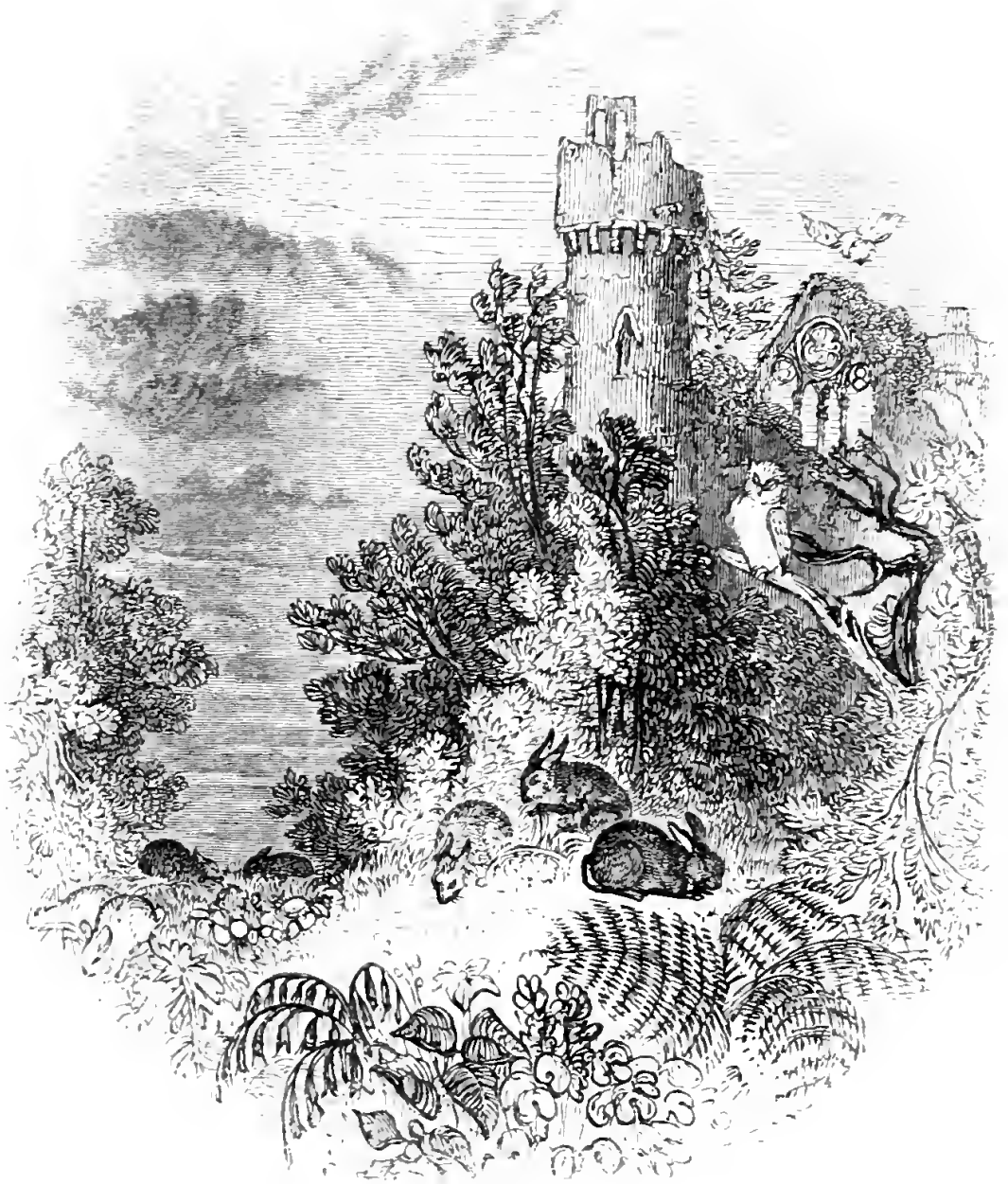
THE privation of light which is experienced from the alternation of night with day, is another proof of the Divine care, to be added to those already given, because by this sleep is directly and indirectly invited. Were it not for this gift of Heaven, all our faculties would soon be exhausted, and comfort and happiness speedily terminate. But now the gracious provision is made, and its advantages are easily perceived.

It appears that by a fundamental law of our nature, a sense of weariness invariably follows a long-continued exercise of our powers, either bodily or mental, and unless fatigue be excessive, it is soon relieved by repose;

during which, if it be sound and healthy, all the voluntary muscles of the body become relaxed, and the nervous system remains comparatively inactive, the whole body obtaining, by this means, the renovation of its powers, which is necessary for the purposes of life. To the sensation of approaching sleep, we are naturally inclined by the periodical return of night. For with the absence of light, the usual excitements cease of that wonderful sense to which it is so admirably adapted—a sense which calls our faculties into action more frequently than any other. All those who, giving themselves to avarice or luxury, turn night into day, violate the general law of Infinite Benevolence.

It is a remarkable proof of the influence of approaching darkness on inferior creatures, that if it should anticipate night by many hours, as happens when the sun is eclipsed in the middle of the day, the birds of the field, as well as the domesticated, show the same disposition to compose themselves to sleep as at the regular period of sunset, when animals in general, but more especially birds, do so; for with the exception of those whose habits are nocturnal, all birds betake themselves with other creatures to sleep at the advance of darkness.

"The dusky holiday of thickening night
Enjoys the chuckling partridge, the still mouse,



EVENING.

The rabbit foraging, the feeding hare,
The nightingale that warbles from the thorn,
And twilight-loving solitary owl,
That skims the meadows, hovers, drops her prey,
Seizes, and screeching to the tower returns;
Her woolly little ones there hiss on high,
And there who will may seek them, but who dares,
Must bide the keen magnanimous rebuff
Of irritated love, and quick descend,
By the maternal talon not in vain
Insulted, baffled, scorn'd, and put to flight."

Evening has its effect on the vegetable world as well as on animated nature. As Hurdis says:—

" What time the sun has from the west withdrawn
The various hues, that graced his cloudy fall—
——————— the recent leaf
Of clover 'gins to sleep, and white with dew,
Closes its tender triple-fingered palm,
Till morning dawn afresh."

The vegetable slumber thus referred to by the poet, was particularly noticed by the great naturalist Linnæus. The flowers of one class, called *papilionaceous*, from *papilio*, the Latin word for butterfly, generally spread out their wings in fine weather to admit the rays of the sun.

Now, some seeds of one of these plants were given to Linnæus by a friend, and having sown them in his green-house, they soon produced two beautiful flowers. The gardener was absent when these were first observed;

and in the evening, when Linnæus took him with a lantern to see them, they were nowhere to be found; so that he himself supposed they had been destroyed by insects, or by some accident; but the next morning, to his great surprise, he discovered his flowers just where they had been the day before.

That evening, too, they were not to be seen; but the next morning they looked as fresh as ever. The gardener said, "These cannot be the same flowers; they must have blown since." But Linnæus was not so easily satisfied; as soon as it was dark he once more visited the plant, and, after lifting up all its leaves, one by one, he found the two flowers folded up, and so closely concealed under them, that it was impossible, at first sight, to discover what they were. This led him to observe other flowers of the same tribe, when he found that all of them, more or less, closed at night; and this he called "the sleep of plants."

When plants grow in the dark, many curious results arise. It frequently happens in America, for instance, that clouds and rain obscure the atmosphere for several days together, and during this time, buds of entire forests expand themselves into leaves. But these assume a pallid hue till the sun appears, when, within the short space of six hours of a clear sky and bright sunshine, their colour

is changed to a beautiful green. On one forest, it is said, the sun had not shone during twenty days, and in the interval the leaves which had attained their full size were almost white. But one forenoon the sun began to shine with its full brightness; and so fast did the colour change that its progress could be perceived; and by the middle of the afternoon the whole of these extensive forests, many miles in length, appeared in their usual summer dress.

To mention another case: in the drain of a coal work in Scotland, under ground, Dr. Robinson accidentally laid his hand on a very luxuriant plant, with large indented foliage, and perfectly white. He had not seen anything like it, nor could any one inform him what it was. The plant was therefore brought into the open air and the light. In a little time, the leaves withered, and soon after new leaves began to spring up, of a green colour, and a different shape to those of the former. On rubbing one of the leaves between his fingers, he found it had the smell of common tansy, and it ultimately proved to be that plant, which had been so changed by growing in the dark. Indeed, it was recollected that some soil had been taken into the drain from a neighbouring garden, some time before the tansy was found so altered.

If, moreover, a plant which has grown without light

be examined chemically, nearly its whole substance appears to consist of mere water, and its odour, so far from being like that of its common nature, very much resembles that of a fungus. How great, then, the contrast, when a plant calculated to regale the senses so completely loses its ordinary qualities, that the eye is not pleased by brightness or variety of colour, while it yields no fragrance, can neither afford nutriment nor medicine, nor ever answer a mechanical purpose. In some instances, however, as in endive and celery, the bleaching of plants serves to correct the acrid taste which they have in their natural state.

Were but the agency of light withdrawn, the plant with which we are now most familiar would be greatly altered in all its natural characters. Its form, colour, taste, and odour would be changed, and it is highly probable they would be totally different. The light colour of the inner leaves of the lettuce, and other common vegetables, is the result of the body of the plant being so compressed as to exclude the admission of light beyond the outer leaves. It is found, too, that if a branch of ivy, or of any spreading plant, happen to enter, while growing, in any dark place, it suffers a total loss of colour; and while it grows very rapidly, its proportions so greatly alter as to bear little resemblance to its original form.

Any such change may therefore well be deprecated, as a great calamity. Everywhere vegetation contributes to the convenience and comfort of domestic and social life, according as its uses are discovered, and means are employed to render them available. Here, too, are found the chief resources of the healing art. Plants silently spread amidst all vegetation, ready for the general benefit. Inferior creatures frequently need them as much as ourselves, and may be seen at particular times choosing and cropping the herbs not employed for food, but the use of which instinct dictates. For ages they furnished to man his only medicine. The old names given to plants, and still sometimes heard in country places, show the virtues they were supposed to possess. Yet, what is the prime mover in all the changes of the vegetable world, from the moment that the germ issues from the soil?—It is light.

Another fact, connected with light and vegetation, must not be suffered to pass unnoticed. One of the remarkable discoveries of Dr. Priestley was, that oxygen gas is given out from the leaves of plants during the day. It was afterwards found that carbonic acid is required in this process, and that the oyxgen is derived from the carbonic acid being decomposed. This was proved very satisfactorily, by the following experiment of M. de Candolle. Two glass jars were

inverted over the same water-bath; the one filled with carbonic acid gas, the other with water containing a sprig of mint, the jars communicating below by means of the water-bath, on the surface of which some oil was poured, to prevent all communication between the water and the atmosphere. The sprig of mint was exposed for twelve successive days to the light of the sun: at the end of each one, the carbonic acid was seen to lessen in quantity, the water rising in the jar to supply the place of what was lost, and at the same time, the plant gave forth a quantity of oxygen, exactly equal to that of the carbonic acid which had disappeared.

A similar sprig of mint, placed in a jar of the same size, full of distilled water, but without access to carbonic acid, gave out no oxygen gas, and soon perished. When, in another experiment, conducted with the same apparatus as was used at first, oxygen gas was placed in the first jar instead of carbonic acid gas, no gas was disengaged in the other jar, which contained a sprig of mint. It is obvious, therefore, that the oxygen gas, obtained from the mint in the first instance, was derived from the decomposition, by the leaves of the mint, of the carbonic acid, which the plant had absorbed from the water.

Solar light is, however, absolutely necessary for this

process; for it is never found to take place at night, nor while the plant is kept in the dark. From its being so much like one of the functions of animals, it may be considered as the respiration of vegetables. It takes place only in a living plant; for if its vitality be destroyed, it can no longer decompose carbonic acid gas under the influence of solar light. Neither the roots, the flowers, nor any other parts of the plant, which have not the green substance at their surface, are able to decompose carbonic acid gas; they produce, indeed, an effect which is in some respects the opposite of this; for they have a tendency to absorb oxygen, and to convert it into carbonic acid.

Such is also the case with the leaves themselves, whenever they are not under the influence of light; thus, during the whole of the night, the same leaves which had been exhaling oxygen during the day, absorb a portion of that element. The oxygen thus absorbed combines with the carbon in the plant, and forms carbonic acid; this is in part given out, but the greater portion either remains attached to the substance of the leaf, or combines with the fluids that form the sap; in the latter case, it is ready to be again presented to the leaf when daylight returns, and when a fresh decomposition is again effected.

The water absorbed by the roots generally carries with it a certain quantity of matter containing carbon, which is conveyed to the leaves, where, during the night, it combines with the oxygen they have absorbed. It is thus changed into carbonic acid, which, when daylight prevails, is decomposed; the oxygen being dissipated, and the carbon retained. The object of the whole process is to obtain carbon in that precise state in which it is most conducive to the nourishment of the plant, and not in the crude condition in which it exists when it is pumped up from the earth.

The absorption of oxygen and the partial disengaging of carbonic acid, which form the nightly changes effected by plants, must tend to impair the atmosphere for supporting animal life; but this is much more than compensated by the greater quantity of oxygen given out by the same plants during the day. At the season of the year, too, when vegetation is most active, the days are longer than the nights; so that the daily process of purification goes on for a greater number of hours than the nightly process by which the air is vitiated.

The oxygen given out by plants, and the carbonic acid resulting from animal respiration, and from various other processes, are quickly spread through the atmosphere, to adapt it to the activity and welfare of all orders

of beings. Were the operations of either suspended, incalculable evils would certainly arise. How beautiful the arrangement by which these two kingdoms of nature unite to execute the same design!

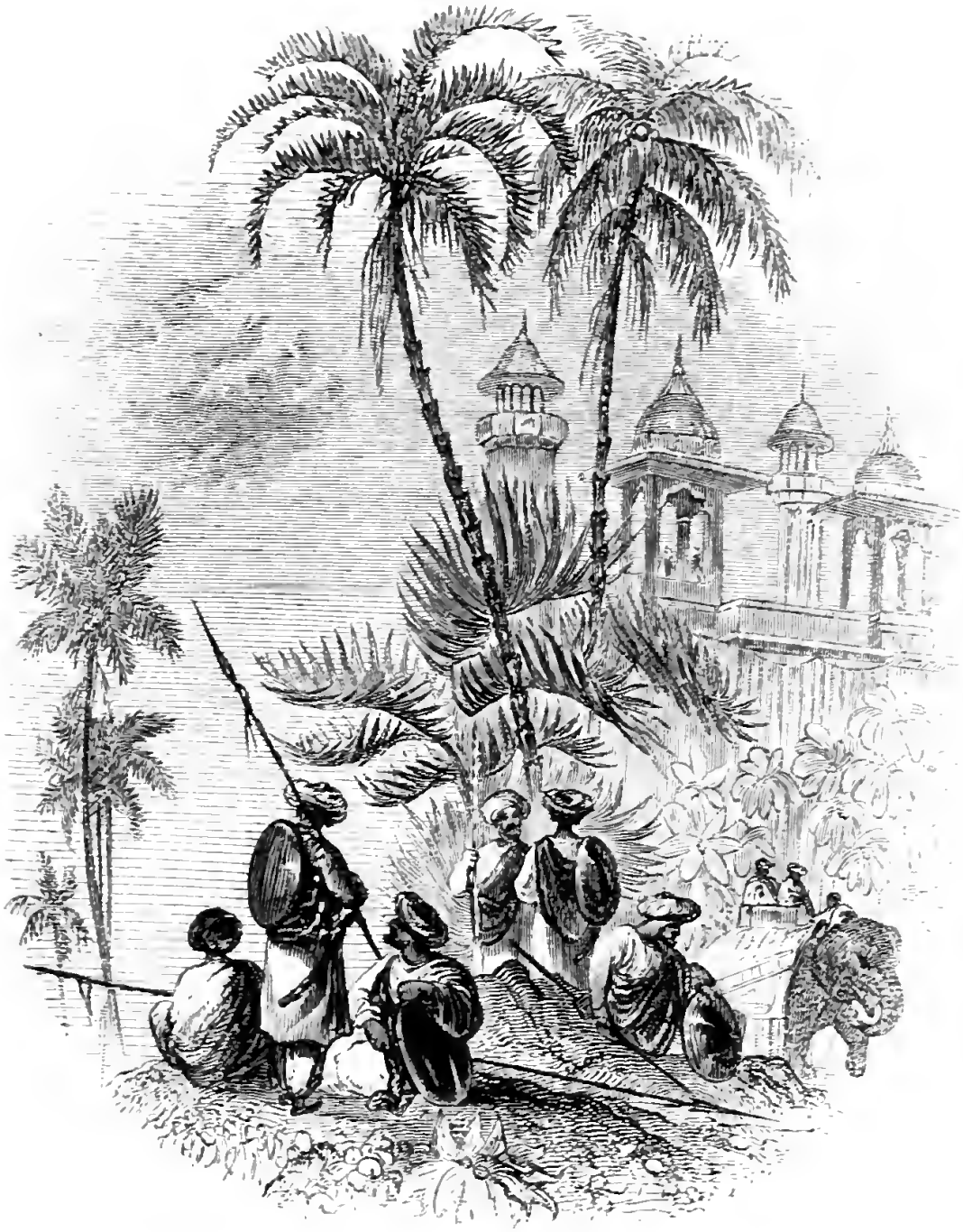
Allusion has already been made to the interest connected with the rising of the bright orb of day; and pleasing is it also as the sun sets in his beauty, and the fields of corn look more lovely under his beams, and the river reflects them in its clear, lucid channel. Then the peasants may be seen returning from their daily toil, or sitting at their cottage-doors, while the milkmaid bears on her head the pail containing many a nutritious draught, and the farmer enjoys the quietude around.

Lake scenery is at such a time very beautiful. "I rode round Grasmere and Rydal lake," says Mrs. Hemans to a friend; "it was a glorious evening, and the imaged heaven in the waters more completely filled my mind, even to overflowing, than, I think, any object in nature ever did before: I quite longed for you: we should have stood in silence before the magnificent scene for an hour, as it flushed and faded, and darkened at last into the deep sky of a summer night. I thought of the scriptural expression, 'A sea of glass mingled with fire;' no other words are fervid enough to convey the least impression of what lay burning before me."

In India, the sunset is often very striking. Bishop Heber mentions one in which, besides the usual beautiful tints of crimson, all which the clouds displayed, and which were strongly contrasted with the deep blue of the sea, and the lighter but equally beautiful blue of the sky, there were in the immediate neighbourhood of the sinking sun, and for some time after his disc had disappeared, large tracks of a pale translucent green, such as he had never seen before, except in a prism, and surpassing every effect of paint, or glass, or gem. Every one on board was touched and awed by the glory of the scene, and many observed, that such a spectacle alone was worth the whole voyage from England.

In some instances, as in America, darkness comes suddenly. There is no lingering twilight to give warning of the need of haste before the shades of night fall on the traveller, and hence, he is sometimes benighted. But the privation is rarely total; for though time is divided in nearly equal proportion between day and night, there are comparatively but few nights in which there is not diffused through the air a sufficient quantity of light for many of the purposes of life.

The lunar orb also comes to the aid of man, when the ruler of the day has retired from view. In Africa, the bright lustre of the moon more than supplies the loss of



SUNSET IN INDIA.

daylight. The beauty of a moonlight night in that part of the world surpasses description. "When the moon rises," says Steedman, "her beams cast a subdued splendour over the finest landscapes in nature, softening their asperities, and investing their sublunar features with a tranquil glory; while the stars spangling the ethereal vault, diffuse over it a radiance of inconceivable brilliancy."

Meanwhile, man gives himself to sleep, that he may refresh his wearied frame, and, it may be, his no less wearied mind, and rise prepared for the active exertions of another day. With what benevolence has this season of repose been arranged! Who has not felt the general influence of "balmy sleep, tired nature's sweet restorer?" Yet how few, comparatively, recognize and adore the goodness from which it comes!

It has already been said, the day should begin with prayer, and with this, assuredly, it should close. As it is "the key of the morning," it should be "the bolt of the night." Many are the evils to which we are then exposed, and of the existence of any we are altogether unconscious. It is, therefore, a duty and a privilege to commit ourselves to the Divine protection, while we connect with this, devout thanksgiving for the mercies of the preceding day. It is peculiarly delightful, too, when

this offering is presented on the family altar, and when a pious household can unite in the song :—

" Inspirer and Hearer of prayer,
Thou Feeder and Guardian of thine,
My all to thy covenant care,
I, sleeping and waking, resign :
If thou art my shield and my sun,
The night is no darkness to me ;
And fast as my moments roll on,
They bring me but nearer to thee."

Of the state to which all believers are going as rapidly as time can bear them, there are, indeed, many animating representations ; and among these it is said, " There shall be no night there," Rev. xxii. 5. Night is the emblem of *ignorance,* but in heaven the saints will attain knowledge, clear and comprehensive, when compared with the obscure and imperfect views they have now from the works and the word of God. Now, says the apostle Paul, " we know in part, and we prophesy in part. But when that which is perfect is come, then that which is in part shall be done away.—For now we see through a glass, darkly ; but then face to face : now I know in part; but then shall I know even as also I am known," 1 Cor. xiii. 9, 10. 12. Here our views are obscure and limited ; they are attained with difficulty and attended by doubt : but there revelation will be as

ample as our finite faculties will permit. What is now already known will shine with new light, and yield a satisfaction not previously experienced, and many things will be disclosed which it had not entered into the heart to conceive. Mysteries will be explained, difficulties will be solved, and excellences will rise to view in the Divine nature, of which there is now no appearance. What glorious objects will then meet the eye! What a flood of happiness will they pour into the soul! Blessed, unspeakably "blessed are the pure in heart: for they shall see God," Matt. v. 8.

Night is also the emblem of *depravity*. Works that are evil, and therefore unfruitful, are emphatically called "works of darkness." But as the righteous enter heaven, they join "the spirits of just men made perfect." They are put in possession of the greatest possible good; and this is not merely the perfection of their own nature, but God himself, who is their everlasting reward. As the soul has wandered from him, it finds no rest on earth, nor could it find repose in heaven, were he not there. The favour of his Maker constituted the happiness of man in paradise, and this will be his felicity when fully restored from the ruins of the fall. It is likeness to God, and the presence of God, which make heaven the asylum of the saints, and the seat of perfect

joy. If they triumph now because they can say, "The Lord is the portion of mine inheritance," how much greater will their exultation be when they know its full value! God himself will be their God. He to whom all perfection belongs, and of whose transcendent excellence this glorious universe is only a shadow, will be there, and will bless them for ever; He will be all in all, around and within them, the light of their understandings, the joy of their hearts, the object of their perpetual praise.

Night is moreover the emblem of *pain*, *distress*, and *dissolution;* but in heaven "there shall be no more death, neither sorrow, nor crying, neither shall there be any more pain: for the former things are passed away." Sin and suffering are united as cause and effect; and as the one will not be committed, so the other will not be endured. No trace of past anguish will remain on the hearts of the righteous, nor will there be any wounds still bleeding, nor any so slightly healed that a touch would cause them again to open, Placid as the bosom of a lake, on which no air breathes, and bright as it is when the sun pours on it the radiance of noontide, shall every mind be in that vast assembly. Who can fully conceive of such tranquillity, where no tempest blows, and the sound of sorrow is

never heard; where no qualms of conscience are felt, and not a thought disturbs the serenity of the soul: where every emotion and reflection is delightful, and all within and without is blessedness! Who can fathom the depth of the declaration, "God shall wipe away all tears from their eyes!" Rev. vii. 17.

Nor is this all we know of the happiness of the redeemed; there is reason to conclude that there will be a constant progress towards higher perfection. Their residence, their bodies, their minds, their knowledge, their virtue, their enjoyments, will form a system of excellency and glory, refining, brightening, and increasing for ever.

To adopt the words of an eminent writer; "To the eye of man, the sun appears a pure light, a mass of unmingled glory. Were we to ascend with a continual flight towards this luminary, and could we, like the eagle, gaze directly on its lustre, we should in our progress behold its greatness continually enlarge, and its splendour become every moment more intense. As we rose through the heavens, we should see a little orb changing gradually into a great world; and as we advanced nearer and nearer, should behold it expanding every way, until all that was before us became an universe of excessive and immeasurable glory. Thus the heavenly inhabitant

will, at the commencement of his happy existence, see the divine system filled with magnificence and splendour, and arrayed in glory and beauty; and as he advances onward through the successive periods of duration, will behold all things more and more luminous, transporting, and sunlike for ever."

Surely then it should be with *us* a matter of devout desire, to be "made meet" for this glorious inheritance. As the splendour of the sun casts into the shade all inferior lights, so does the "far more exceeding and eternal weight of glory" all that is connected with the present world. Under this conviction be it *ours* to live;—then shall no good thing be withheld during our earthly pilgrimage, and at its close, an entrance shall be ministered to us abundantly into the everlasting kingdom of our Lord and Saviour Jesus Christ, 2 Pet.i. 11.

THE END.

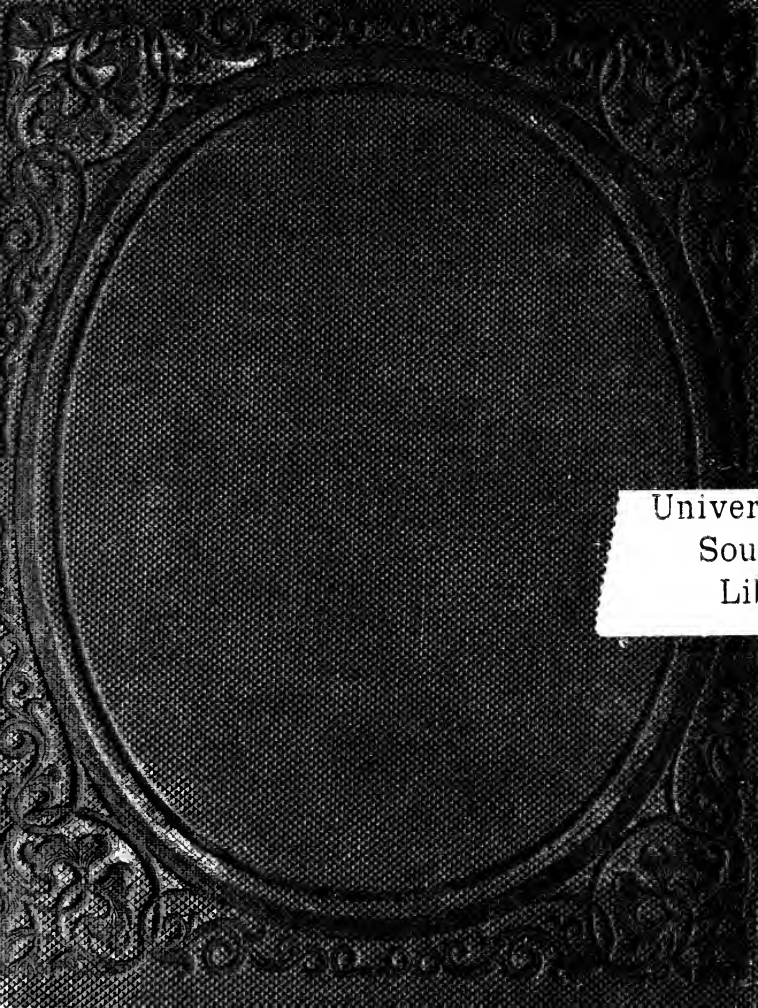
LONDON: SAMUEL BENTLEY, BANGOR HOUSE, SHOE LANE.

University of California
SOUTHERN REGIONAL LIBRARY FACILITY
305 De Neve Drive - Parking Lot 17 • Box 951388
LOS ANGELES, CALIFORNIA 90095-1388
Return this material to the library from which it was borrowed.

APR 16 2007

UC SOUTHERN REGIONAL LIBRARY FACILITY

B 000 002 987 6


Univer
Sou
Li